DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Part 1910

[Docket No. S–777]

RIN 1218–AB36

Ergonomics Program

AGENCY: Occupational Safety and Health Administration (OSHA), Department of Labor.

ACTION: Final rule.

SUMMARY: The Occupational Safety and Health Administration is issuing a final Ergonomics Program standard (29 CFR 1910.900) to address the significant risk of employee exposure to ergonomic risk factors in jobs in general industry workplaces. Exposure to ergonomic risk factors on the job leads to musculoskeletal disorders (MSDs) of the upper extremities, back, and lower extremities. Every year, nearly 600,000 MSDs that are serious enough to cause time off work are reported to the Bureau of Labor Statistics by general industry employers, and evidence suggests that an even larger number of non-lost worktime MSDs occur in these workplaces every year.

The standard contains an ''action trigger,'' which identifies jobs with risk factors of sufficient magnitude, duration, or intensity to warrant further examination by the employer. This action trigger acts as a screen. When an employee reports an MSD, the employer must first determine whether the MSD is an MSD incident, defined by the standard as an MSD that results in days away from work, restricted work, medical treatment beyond first aid, or MSD symptoms or signs that persist for 7 or more days. Once this determination is made, the employer must determine whether the employee's job has risk factors that meet the standard's action trigger. The risk factors addressed by this standard include repetition, awkward posture, force, vibration, and contact stress. If the risk factors in the employee's job do not exceed the action trigger, the employer does not need to implement an ergonomics program for that job.

If an employee reports an MSD incident and the risk factors of that employee's job meet the action trigger, the employer must establish an ergonomics program for that job. The program must contain the following elements: hazard information and reporting, management leadership and employee participation, job hazard analysis and control, training, MSD management, and program evaluation. The standard provides the employer with several options for evaluating and controlling risk factors for jobs covered by the ergonomics program, and provides objective criteria for identifying MSD hazards in those jobs and determining when the controls implemented have achieved the required level of control.

The final standard would affect approximately 6.1 million employers and 102 million employees in general industry workplaces, and employers in these workplaces would be required over the ten years following the promulgation of the standard to control approximately 18 million jobs with the potential to cause or contribute to covered MSDs. OSHA estimates that the final standard would prevent about 4.6 million work-related MSDs over the next 10 years, have annual benefits of approximately $9.1 billion, and impose annual compliance costs of $4.5 billion on employers. On a per-establishment basis, this equals approximately $700; annual costs per problem job fixed are estimated at $250.

DATES: This final rule becomes effective on January 16, 2001.

Compliance. Start-up dates for specific provisions are set in paragraph (w) of § 1910.900. However, affected parties do not have to comply with the information collection requirements in the final rule until the Department of Labor publishes in the **Federal Register** the control numbers assigned by the Office of Management and Budget (OMB). Publication of the control numbers notifies the public that OMB has approved these information collection requirements under the Paperwork Reduction Act of 1995.

ADDRESSES: In compliance with 28 U.S.C. 2112(a), the Agency designates the Associate Solicitor for Occupational Safety and Health, Office of the Solicitor, Room S–4004, U.S. Department of Labor, 200 Constitution Avenue, NW., Washington, DC 20210, as the recipient of petitions for review of the standard.

FOR FURTHER INFORMATION CONTACT: OSHA's Ergonomics Team at (202) 693–2116, or visit the OSHA Homepage at www.osha.gov.

SUPPLEMENTARY INFORMATION:

Table of Contents

The preamble and standard are organized as follows:

References to documents, studies, and materials in the rulemaking record are found throughout the text of the preamble. Materials in the docket are identified by their Exhibit numbers, as follows: ''Ex. 26–1'' means Exhibit 26–1 in Docket S–777. A list of the Exhibits and copies of the Exhibits are available in the OSHA Docket Office.

I. Introduction

A. Overview

This preamble discusses the data and events that led OSHA to issue the final Ergonomics Program standard (Section II), and the Agency's legal authority for promulgating the rule (Section III). This discussion is followed by a detailed paragraph-by-paragraph summary and explanation of the final rule, including the Agency's reasons for including each provision and OSHA's responses to the many substantive issues that were raised in the proposal and during the rulemaking (Section IV).

The summary and explanation of the standard is followed by a lengthy discussion of the evidence on the health effects that are associated with worker exposure to MSD hazards (Section V). The next section discusses the nature and degree of ergonomic-related risks confronting workers in general industry jobs (Section VI), and assesses the significance of those risks (Section VII). The preamble also contains a summary of the Final Economic and Final Regulatory Flexibility Analysis (Section VIII). Finally, the preamble describes the information collections associated with the final standard (Section XV).

B. The Need for an Ergonomics Program Standard

Work-related musculoskeletal disorders (MSDs) currently account for one-third of all occupational injuries and illnesses reported to the Bureau of Labor Statistics (BLS) by employers every year. Although the number of MSDs reported to the BLS, like all occupational injuries and illnesses, has declined by more than 20% since 1992, these disorders have been the largest single job-related injury and illness problem in the United States for the last decade, consistently accounting for 34% of all reported injuries and illnesses. In 1997, employers reported a total of 626,000 lost worktime MSDs to the BLS, and these disorders accounted for $1 of every $3 spent for workers' compensation in that year. This means that employers are annually paying more than $15 billion in workers' compensation costs for these disorders, and other expenses associated with work-related MSDs, such as the costs of training new workers, may increase this total to $45 billion a year. Workers with severe MSDs often face permanent disability that prevents them from returning to their jobs or handling simple, everyday tasks like combing their hair, picking up a baby, or pushing a shopping cart. For example, workers who must undergo surgery for work-related carpal tunnel syndrome often lose 6 months or more of work.

Thousands of companies have taken action to address and prevent these problems. OSHA estimates that 46 percent of all employees but only 16 percent of all workplaces in general industry are already protected by an ergonomics program, because their employers have voluntarily elected to implement an ergonomics program. (The difference in these percentages shows that many large companies, who employ the majority of the workforce, already have these programs, and that many smaller employers have not yet implemented them.) Based on its review of the evidence in the record as a whole, OSHA concludes that the final standard is needed to protect employees in general industry workplaces who are at significant risk of incurring a work-related musculoskeletal disorder but are not currently protected by an ergonomics program.

C. The Science Supporting the Standard

A substantial body of scientific evidence supports OSHA's effort to provide workers with ergonomic protection (see the Health Effects, Risk Assessment, and Significance of Risk sections (Sections V, VI, and VII, respectively) of this preamble, below). This evidence strongly supports two basic conclusions: (1) There is a positive relationship between work-related musculoskeletal disorders and employee exposure to workplace risk factors, and (2) ergonomics programs and specific ergonomic interventions can substantially reduce the number and severity of these injuries.

In 1998, the National Research Council/National Academy of Sciences found a clear relationship between musculoskeletal disorders and work and between ergonomic interventions and a decrease in the number and severity of such disorders. According to the Academy, ''Research clearly demonstrates that specific interventions can reduce the reported rate of musculoskeletal disorders for workers who perform high-risk tasks'' (*Work-Related Musculoskeletal Disorders: The Research Base*, ISBN 0–309–06327–2 (1998)). A scientific review of hundreds of peer-reviewed studies involving workers with MSDs by the National Institute for Occupational Safety and Health (NIOSH 1997) also supports this conclusion.

The evidence, which is comprised of peer-reviewed epidemiological, biomechanical and pathophysiological studies as well as other published evidence, includes:

II. More than 2,000 articles on work-related MSDs and workplace risk factors;

II. A 1998 study by the National Research Council/National Academy of Sciences on work-related MSDs;

- A critical review by NIOSH of more than 600 epidemiological studies addressing the effects of exposure to workplace risk factors (1997);
- A 1997 General Accounting Office report of companies with ergonomics programs;

I. Other evidence and analyses in the Health Effects section of the preamble to the final rule;

II. Hundreds of case studies from companies with successful ergonomics programs; and

I. Testimony and evidence submitted to the record by expert witnesses, workers, safety and health professionals, and others, which is discussed throughout the preamble to the final rule.

Taken together, this evidence indicates that:

- High levels of exposure to ergonomic risk factors on the job lead to an increased incidence of work-related MSDs among exposed workers;
- Reducing exposure to physical risk factors on the job reduces the incidence and severity of work-related MSDs;
- Many work-related MSDs are preventable; and
- Ergonomics programs are demonstrably effective in reducing risk, decreasing exposure and protecting workers against work-related MSDs.

As with any scientific field, research in ergonomics is ongoing. The National Academy of Sciences is currently undertaking another review of the science in order to expand on its 1998 study. OSHA has examined all of the research results in the record of this rulemaking in order to ensure that the final Ergonomics Program standard is based on the best available and most current evidence. Although more research is always desirable, OSHA finds that more than enough evidence already exists to demonstrate the need for a final standard. In the words of the American College of Occupational and Environmental Medicine, the world's largest occupational medical society, ''there is an adequate scientific foundation for OSHA to proceed * * * and, therefore, no reason for OSHA to delay the rulemaking process * * *.''

D. Information OSHA Is Providing To Help Employers Address Ergonomic Hazards

Much literature and technical expertise on ergonomics already exists and is available to employers, both through OSHA and a variety of other sources. For example:

- Information is available from OSHA's ergonomics Web page, which can be accessed from OSHA's World Wide Web site at *http://www.osha.gov* by scrolling down and clicking on ''Ergonomics'';
- Many publications, informational materials and training courses, which are available from OSHA through Regional Offices, OSHA-sponsored educational centers, OSHA's state consultation programs for small businesses, and through the Web page;
- Publications on ergonomics programs, which are available from NIOSH at 1–800–35–NIOSH. NIOSH's Web page is also ''linked'' to OSHA's ergonomics Web page;
- OSHA's state consultation programs, which will provide free on-site consultation services to employers requesting help in implementing their ergonomics programs; and
- OSHA-developed compliance assistance materials, which are available as non-mandatory appendices to the standard, electronic compliance assistance training materials (e-cats) on specific tasks (*e.g.*, lifting) or work environments (*e.g.*, nursing homes). OSHA is also making several publications available on the web, such as the Easy Ergonomics Booklet, Fact Sheets, and so on. These materials can be obtained by accessing OSHA's Internet home page at *www.OSHA.gov.*

II. Events Leading to the Development of the Final Standard

In this final standard, OSHA has relied on its own substantial experience with ergonomics programs, the experience of private firms and insurance companies, and the results of research studies conducted during the last 30 years. Those experiences clearly show that: (1) Ergonomics programs are an effective way to reduce occupational MSDs; (2) ergonomics programs have consistently achieved that objective; (3) OSHA's standard is consistent with these programs; and (4) the standard is firmly grounded in the OSH Act and OSHA policies and experience. The primary lesson to be learned is that employers with effective, well-managed ergonomics programs achieve significant reductions in the severity and number of work-related MSDs that their employees experience. These programs also generally improve productivity and employee morale and reduce employee turnover and absenteeism (see Section VI of this preamble, and Chapters IV (Benefits) and V (Costs of Compliance) of OSHA's Final Economic Analysis (Ex. 28–1)).

OSHA's long experience with ergonomics is apparent from the chronology below. As this table shows, the Agency has been actively involved in ergonomics for more than 20 years.

OSHA Ergonomics Chronology

March 1979	OSHA hires its first ergonomist.
Early 1980s	OSHA begins discussing ergonomic interventions with labor, trade associations and professional organizations. OSHA issues citations to Hanes Knitwear and Samsonite for ergonomic hazards.
August 1983	The OSHA Training Institute offers its first course in ergonomics.
February 1986	OSHA publishes "Working Safely with Video Display Terminals," its first publication concerning ergonomics as it applies to the use of computer technology
May 1986	OSHA begins a pilot program to reduce back injuries through review of injury records during inspections and recommendations for job redesign using NIOSH's Work Practices Guide for Manual Lifting.
October 1986	The Agency publishes a Request for Information on approaches to reduce back injuries resulting from manual lifting. (57 FR 34192)
November 1988	OSHA/Iowa Beef Processors reach first corporate-wide settlement to reduce ergonomic hazards at 8 IBP locations nationwide.
July 1990	OSHA/UAW/Ford corporate-wide settlement agreement commits Ford to reduce ergonomic hazards in 96 percent of its plants through a model ergonomics program.
August 1990	The Agency publishes "Ergonomics Program Management Guidelines for Meatpacking Plants."
Fall 1990	OSHA creates the Office of Ergonomics Support and hires more ergonomists.
November 1990	OSHA/UAW/GM sign agreement bringing ergonomics programs to 138 GM plants employing more than 300,000 workers. Throughout the early 90s, OSHA signed 13 more corporate-wide settlement agreements to bring ergonomics programs to nearly half a million more workers.
July 1991	OSHA publishes "Ergonomics: The Study of Work," as part of a nationwide education and outreach program to raise awareness about ways to reduce musculoskeletal disorders.
July 1991	More than 30 labor organizations petition Secretary of Labor to issue an Emergency Temporary Standard on ergonomics.
January 1992	OSHA begins a special emphasis inspection program on ergonomic hazards in the meatpacking industry.
April 1992	Secretary of Labor denies petition for an Emergency Temporary Standard but commits to moving forward with section 6 (b) rulemaking.
August 1992	OSHA publishes an Advance Notice of Proposed Rulemaking on ergonomics.
1993	OSHA conducts a major survey of general industry and construction employers to obtain information on the extent of ergonomics programs in industry and other issues.
March 1995	OSHA begins a series of meetings with stakeholders to discuss approaches to a draft ergonomics standard.
January 1997	OSHA/NIOSH conference on successful ergonomic programs held in Chicago.
April 1997	OSHA introduces the ergonomics web page on the Internet.
February 1998	OSHA begins a series of national stakeholder meetings about the draft ergonomics standard under development.
March 1998	OSHA releases a video entitled "Ergonomic Programs That Work."
February 1, 1999	OSHA begins small business (Small Business Regulatory Enforcement Fairness Act (SBREFA) review of its draft ergonomics rule, and makes draft regulatory text available to the public.
March 1999	OSHA/NIOSH/Institute of Industrial Engineers hold Applied Ergonomics Conference in Houston
April 30, 1999	OSHA's Assistant Secretary receives the SBREFA report on the draft ergonomics program proposal, and the Agency begins to address the concerns raised in that report.
November 23, 1999	OSHA publishes its proposed ergonomics program standard.
March 2000	OSHA/NIOSH/Institute of Industrial Engineers hold Applied Ergonomics Conference in Los Angeles
March–May 2000	OSHA holds 9 weeks of public hearings and receives 18,337 pages of testimony from 714 witnesses.
November 23, 1999 through August 10, 2000.	OSHA receives nearly 11,000 comments and briefs consisting of nearly 50,000 pages collectively, into the docket of the ergonomics rulemaking.
October 27, 2000	The Occupational Safety and Health Review Commission finds that manual lifting of nursing home patients is a known and recognized risk factor for lower back pain.

A. Regulatory and Voluntary Guidelines Activities

In 1989, OSHA issued the *Safety and Health Program Management Guidelines* (54 FR 3904, Jan. 26, 1989), which are voluntary program management guidelines to assist employers in developing effective safety and health programs. These program management guidelines, which are based on the widely accepted safety and health principles of management commitment and employee involvement, worksite hazard analysis, hazard prevention and control, and employee training, also serve as the foundation for effective ergonomics programs. In August 1990, OSHA issued the *Ergonomics Program Management Guidelines for Meatpacking Plants* (Ex. 2–13), which utilized the four program components from the safety and health management guidelines, supplemented by other ergonomics-specific program elements (*e.g.,* medical management). The ergonomic guidelines were based on the best available scientific evidence, the best practices of successful companies with these programs, advice from the National Institute for Occupational Safety and Health (NIOSH), the scientific literature, and OSHA's experience with enforcement actions. Many commenters in various industries have said that they have implemented their ergonomics programs primarily on the basis of the OSHA ergonomics guidelines (Exs. 3–50, 3–61, 3–95, 3–97, 3–113, 3–121, 3–125), and there has been general agreement among stakeholders that these program elements should be included in any OSHA ergonomics standard (Exs. 3–27, 3–46, 3–51, 3–61, 3–89, 3–95, 3–113, 3–119, 3–160, 3–184).

OSHA also has encouraged other efforts to address the prevention of work-related musculoskeletal disorders. For example, OSHA has actively participated in the work of the ANSI Z–365 Committee, which was entrusted with the task of developing a consensus standard for the control of cumulative trauma disorders. The Agency also has sponsored and participated in more than 11 Ergonomics Best Practices conferences.

1. Petition for Emergency Temporary Standard

On July 31, 1991, the United Food and Commercial Workers Union (UCFW), along with the AFL–CIO and 29 other labor organizations, petitioned OSHA to take immediate action to reduce the risk to employees of exposure to ergonomic hazards (Ex. 2–16). The petition requested that OSHA issue an emergency temporary standard (ETS) on ''Ergonomic Hazards to Protect Workers from Work-Related Musculoskeletal Disorders (Cumulative Trauma Disorders)'' under section 6(c) of the Act. The petitioners also requested, consistent with section 6(c), that OSHA promulgate, within 6 months of issuance of the ETS, a permanent standard to protect workers from cumulative trauma disorders in both general industry and construction.

Based on the statutory constraints and legal requirements governing issuance of an ETS, OSHA calculated that the basis to support issuance of an ETS was not sufficient. Accordingly, on April 17, 1992, OSHA decided not to issue an ETS on ergonomic hazards (Ex. 2–29). OSHA agreed with the petitioners, however, that available information, including the Agency's experience and information in the ETS petition and supporting documents, supported the initiation of a rulemaking, under section 6(b)(5) of the Act, to address ergonomic hazards.

2. Advance Notice of Proposed Rulemaking

At the time OSHA issued the *Ergonomic Program Management Guidelines for Meatpacking Plants* (Ex. 2–13), the Agency also indicated its intention to begin the rulemaking process by asking the public for information about musculoskeletal disorders (MSDs). The Agency indicated that this could be accomplished through a Request for Information (RFI) or an Advance Notice of Proposed Rulemaking (ANPR) consistent with the Administration's Regulatory Program. Subsequently, OSHA formally placed ergonomics rulemaking on the regulatory agenda (Ex. 2–17) and decided to issue an ANPR on this topic.

In June 1991, OSHA sent a draft copy of the proposed ANPR questions for comment to 232 parties, including OSHA's advisory committees, labor organizations (including the petitioners), trade associations, occupational groups, and members of the ergonomics community (Ex. 2–18). OSHA requested comments on what questions should be presented in the ANPR. OSHA received 47 comments from those parties. In addition, OSHA met with the Chemical Manufacturers Association, Organization Resources Counselors, Inc., the AFL–CIO and several of its member organizations. OSHA reviewed the comments and submissions received and incorporated relevant suggestions and comments into the ANPR.

On August 3, 1992, OSHA published the ANPR in the **Federal Register** (57 FR 34192), requesting information for consideration in the development of an ergonomics standard. OSHA received 290 comments in response to the ANPR. Those comments have been carefully considered by the Agency in developing the final ergonomics program standard.

3. Outreach to Stakeholders

In conjunction with the process of developing the proposed ergonomics rule, OSHA established various communication and outreach efforts. These efforts were initiated in response to requests by individuals who would be affected by the rule (stakeholders) that they be provided with the opportunity to present their concerns about an ergonomics rule and that they be kept apprized of the efforts OSHA was making in developing a proposed rule. For example, in March and April 1994, OSHA held meetings with industry, labor, professional and research organizations covering general industry, construction, agriculture, healthcare, and the office environment. A list of those attending the meetings and a record of the meetings has been placed in the public record of this rulemaking (Ex. 26–1370).

In March, 1995, OSHA provided a copy of an early draft proposed ergonomics rule and preamble to these same organizations. Thereafter, during April 1995, OSHA met again with these groups to discuss whether the draft proposed rule had accurately responded to the concerns raised earlier. A summary of the comments has been placed in the public record (Ex. 26–1370).

During 1998, OSHA met with nearly 400 stakeholders to discuss ideas for a proposed standard. The first series of meetings was held in February in Washington, D.C. and focused on general issues, such as the scope of the standard and what elements of an ergonomics program should be included in a standard. The second series of meetings, held in July in Kansas City and Atlanta, focused on what elements and activities should be included in an ergonomics program standard. The third set of meetings was held in September in Washington, D.C. and emphasized revisions to the elements of the proposal based on previous stakeholder input. A summary of those meetings was placed on the OSHA web site and in the public docket (Ex. 26–1370). OSHA solicited input from its stakeholders again the next year, when it posted a working draft of its ergonomics standard after its release for Small Business Regulatory Enforcement Fairness Act (SBREFA) Panel review.

4. Small Business Regulatory Enforcement Fairness Act (SBREFA) Panel

In accordance with SBREFA and to gain insight from employers with small businesses, OSHA, the Office of Management and Budget (OMB), and the Small Business Administration (SBA) created a Panel to review and comment on a working draft of the ergonomics program standard. As required by SBREFA, the Panel sought the advice and recommendations of potentially affected Small Entity Representatives (SERs). A total of 21 SERs from a variety of industries participated in the effort. The working draft and supporting materials (a brief summary of a preliminary economic analysis, the risk assessment, and other materials) were sent to the SERs for their review. On March 24–26, 1999, the Panel participated in a series of discussions with the SERs to answer questions and receive comments. The SERs also provided written comments, which served as the basis of the Panel's final report (Ex. 23). The final SBREFA Panel Report was submitted to the Assistant Secretary on April 30, 1999. The findings and recommendations made by the Panel are addressed in the proposed rule, preamble, and economic analysis (see the discussion in Section

VIII, Summary of the Final Economic Analysis and Regulatory Flexibility Analysis).

5. Issuance of Proposed Rule

On November 23, 1999, OSHA published a proposed ergonomics program standard to address the significant risk of work-related musculoskeletal disorders (MSDs) confronting employees in various jobs in general industry workplaces (64 FR 65768). The proposed standard would have required general industry employers covered by the standard to establish an ergonomics program containing some or all of the elements typical of successful ergonomics programs: management leadership and employee participation, job hazard analysis and control, hazard information and reporting, training, MSD management, and program evaluation, depending on the types of jobs in their workplace and whether a musculoskeletal disorder covered by the standard had occurred. Employers whose employees perform manufacturing or manual handling jobs were required to implement a basic ergonomics program in those jobs.

The basic program would have included the following elements: management leadership and employee participation, and hazard information and reporting. If an employee in a manufacturing or manual handling job experienced an OSHA-recordable MSD determined by the employer to be covered by the standard, the employer would have been required to implement a full ergonomics program for that job and all other jobs in that establishment involving the same physical work activities. The full program would have included, in addition to the elements in the basic program, a hazard analysis of the job; the implementation of engineering, work practice or administrative controls to eliminate or substantially reduce the hazards identified in that job; training the employees and their supervisors in that job; and providing MSD management, including where appropriate, temporary work restrictions and access to a health care provider or other professional if a covered MSD occurred. General industry employees in jobs other than manufacturing or manual handling who experienced a covered MSD determined by the employer to be covered by the standard also would have been required by the proposal to implement an ergonomics program for those jobs.

6. Solicitation of Public Comment on the Proposed Rule

The notice of proposed rulemaking invited public comment on any aspects of the proposed ergonomics standard until the close of the comment period ending on February 1, 2000.

After receiving a number of requests for an extension of the written comment period, OSHA published a **Federal Register** notice (65 FR 4795) to extend the deadline for public, pre-hearing comments to March 2, 2000 and to reschedule the informal public hearings in Washington, D.C. to begin March 13, 2000 and run through April 7, 2000. Subsequently, the Agency published a **Federal Register** notice (65 FR 19702) to re-schedule and extend the hearings in Portland, OR by 2 days, from April 24, 2000 through May 3, 2000. In addition, a final week of informal public hearings (65 FR 13254) was scheduled to take place in Washington, D.C. from May 8, 2000 through May 12, 2000.

During the early stages of the public comment period, it was brought to OSHA's attention that the proposed ergonomics program standard published on November 23, 1999 (64 FR 65768) did not provide an analysis of the economic impacts of the rule on State and local governments, the United States Postal Service, or the railroads. To provide this additional information and analysis, OSHA published a supplement (65 FR 33263) to the Agency's Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis (Ex. 28–1) of the economic impact of the Ergonomics Program Rule. OSHA also established pre-hearing and post-hearing comment periods ending June 22, 2000 and August 10, 2000, respectively, to address the analysis of economic impacts in those three industries. An informal public hearing was held in Atlanta, GA on July 7, 2000, to provide an opportunity for witnesses to question the OSHA Panel on the supplemental analysis.

Collectively, the public hearings concerning the proposed ergonomics program standard generated 18,337 pages of transcript based on testimony from 714 hearing witnesses, including those representing public entities, private industry, industry associations, labor unions and private individuals.

More than 5,900 pre-hearing comments were filed in response to the proposed ergonomics program standard. A 45-day post-hearing comment period and a 45-day summary and brief period were established, with final briefs due to be postmarked no later than August 10, 2000. A total of 240 post hearing submissions were received. Collectively, a total of nearly 11,000 exhibits consisting of nearly 50,000 pages were submitted over the whole period.

B. Other OSHA Efforts In Ergonomics

In 1996, OSHA developed a strategy to address ergonomics through a four-pronged program including training, education, and outreach activities; study and analysis of the work-related hazards that lead to MSDs; enforcement; and rulemaking.

1. Training, Education, and Outreach

a. Training. The OSHA ergonomics web page has been an important part of the Agency's education and outreach effort. Other OSHA efforts in training, education and outreach include the following:

- Grants to train workers and employees about hazards and hazard abatement.
- Three training courses in ergonomics through the OSHA Training Institute available for OSHA compliance officers, one of which is open to the public;
- One day training for nursing home operators, at more than 500 nursing homes in each of seven targeted states;
- Booklets on ergonomics, ergonomics programs, and computer workstations, such as ''Ergonomics Program Management Guidelines for Meatpacking Plants'' and ''Ergonomics: the Study of Work,'' both of which are available on OSHA's Website.
- Videotapes on ergonomics programs in general industry and specifically in nursing homes.

OSHA has awarded almost $3 million for 25 grants addressing ergonomics, including lifting hazards in healthcare facilities and hazards in the red meat and poultry industries. These grants have enabled workers and employers to identify ergonomic hazards and implement workplace changes to abate these hazards.

Some grant program highlights follow:

- The United Food and Commercial Workers International Union (UFCW) conducted joint labor-management ergonomics training at a meatpacking plant that resulted in a major effort at the plant to combat cumulative trauma disorders. The program was so successful that management asked the UFCW to conduct the ergonomics training and work with management at some of its other facilities.
- The University of California at Los Angeles (UCLA) and the Service Employees International Union (SEIU) both had grants for preventing lifting injuries in nursing homes. SEIU developed a training program that was used by UCLA to train nursing home workers in California. UCLA also worked with some national back injury prevention

programs. At least one of the nursing home chains has replicated the program in other states.

- Mercy Hospital in Des Moines, Iowa, had a grant to prevent lifting injuries in hospitals. It trained over 3,000 hospital workers in Des Moines and surrounding counties. It had a goal of reducing lost work days by 15 percent. The goal was surpassed, and, six months after the training, none of those trained experienced a lost workday due to back injury.
- Hunter College in New York City trains ergonomics trainers for the United Paperworkers International Union. The trainers then return to their locals and conduct ergonomics training for union members. As a result of this training, changes are being made at some workplaces. Examples include purchasing new equipment that eliminates or reduces workers' need to bend or twist at the workstation, rotating workers every two hours with a ten-minute break before each rotation, and modifying workstations to reduce worker strain.

b. Education and Outreach. To provide a forum to discuss ergonomic programs and to augment information in the literature with the experience of companies of different sizes and from a variety of industries, OSHA and NIOSH sponsored the first in a series of conferences that brought industry, labor, researchers, and consultants together to discuss what works in reducing MSDs. The 1997 OSHA and NIOSH conference was followed by 11 more regional conferences across the country. OSHA and NIOSH held the second national conference on ergonomics in March of 1999. More than 200 presentations were given at the conferences on how companies have successfully reduced MSDs. Presentations were made by personnel from large and small companies in many different industries.

Other examples of successful ergonomics programs have come from OSHA's Voluntary Protection Program (VPP). The VPP program was established by OSHA to recognize employers whose organizations have exemplary workplace safety health programs. Several sites that have been accepted into VPP have excellent ergonomics programs.

In addition to OSHA's enforcement efforts, the Agency's Ergonomics Program Management Guidelines for Meatpacking Plants (''Guidelines'') (Ex. 2–13) are viewed by many as essential to the implementation of successful workplace programs addressing ergonomic hazards. For example, in contrasting OSHA's proposal to the *Guidelines,* IBP Inc.'s Bob Wing acknowledged that the *Guidelines* had been successful (Ex. 30–4046, p.1). Similarly, the American Meat Institute (''AMI''), the main representative for the U.S. meat industry, including 276 meat packers and processors, who operate 559 facilities, acknowledged that the industry worked with OSHA on the *Guidelines,* and has been using them for nearly ten years (Ex. 30–3677, p.1). The AMI notes that the *Guidelines* work and that the industry has made substantial progress in addressing ergonomic issues since development of the *Guidelines* (*id.* at 1–4). The AMI recommended that the *Guidelines* be extended throughout general industry (*id.* at 4). The utility of OSHA's *Guidelines* also was hailed by the United Food and Commercial Workers' Union, which noted that upon publication of the *Guidelines,* industry began to respond both from the standpoint of technology as well as ergonomics programs (Ex. 32–210–2, pp. 25–26). The success of the *Guidelines* led to their use and acceptance in other industries. The poultry industry appears to have secured substantial reductions in chronic MSDs from adherence to the principles in the document (Ex. 30–3375, p.1.).

2. Ergonomics Best Practices Conferences

During the period from Sept. 17, 1997 through Sept. 29, 1999, OSHA and its Regional Education Centers co-sponsored 11 Ergonomics Best Practices Conferences. These Conferences were designed to provide good examples of practical and inexpensive ergonomics interventions implemented by local companies. The concept was that if OSHA and its Regional partners could initiate the development of a network of local employers, contractors, and educators to provide practical information to solve ergonomics problems, it would be assisting employers in providing a workplace for employees that would be ''free of recognized safety and health hazards.'' To date, attendance has exceeded 2,400 participants, including employers, contractors, and employees. Finally, OSHA has made hundreds of outreach presentations to labor, trade associations, large and small businesses, and professional organizations during the development of the proposed rule.

3. Enforcement

In the absence of a federal OSHA ergonomics standard, OSHA has addressed ergonomics in the workplace under the authority of section 5(a)(1) of the OSHAct. This section is referred to as the General Duty Clause and requires employers to provide work and a work environment free from recognized hazards that are causing or are likely to cause death or serious physical harm.

OSHA has successfully issued over 550 ergonomics citations under the General Duty Clause. In the majority of these cases, cited employers have recognized that the implementation of ergonomics programs is in their best interest and that of their employees. Examples of companies cited under the General Duty Clause for ergonomics hazards and which then realized a substantial reduction in injuries and illnesses after implementing ergonomics programs include: the Ford Motor Company, Empire Kosher Foods, Sysco Foods, and the Kennebec Nursing Home.

Two cases have been decided so far by the Occupational Safety and Health Review Commission.

In the first general duty clause case litigated by the Occupational Safety and Health Review Commission, *Pepperidge Farm,* the Review Commission recognized that excessive lifting and excessive repetitions were recognized ergonomic hazards that had caused and were likely to cause serious physical harm to employees whose work tasks required such activity. The Commission specifically noted that carpal tunnel syndrome and other soft tissue injuries found at the cited plant were caused by work tasks; the Commission relied principally on direct medical evidence, expert medical opinion, the incidence of injury, and the epidemiological studies and testimony in the record in reaching this finding. The Commission also agreed that an employer could be required to undertake a process-based, incremental approach to abating ergonomic hazards. The citations relating to the excessive lifting hazard were affirmed by the Commission, while those relating to the excessive repetitions were vacated based on a finding that the Secretary had failed to prove feasible means of abatement in addition to those found to have been undertaken by the company.

In the second general duty clause case litigated by the Commission, *Beverly Enterprises,* the Commission held that the company's practices for lifting patients in its nursing homes exposed its nursing assistants to a serious recognized hazard. Beverly's nursing assistants suffered a disproportionate number of cases of lower back pain, which was often so severe that the employee would be off work for long periods of time, in some cases six months to over a year. The Commission found that manual lifting of nursing home residents is a known and recognized risk factor for lower back pain and that the company recognized the hazard.

When serious physical harm cannot be documented in the work environment but hazards have been identified by OSHA, compliance officers both discuss the hazards with the employer during the closing conference of an inspection and write a letter to the employer. These letters are called ''Ergonomic Hazard Alert Letters.'' From fiscal year 1997 through October 3, 2000, approximately 498 such letters have been sent to public and private sector employers under Section 20 of the OSH Act. These letters involve no penalty and are strictly consultative in nature; they reflect OSHA's responsibility to provide consultation on ergonomics to employers. Ergonomic Hazard Alert Letters have been sent to employers in approximately 50% of OSHA's ergonomic inspections.

Since ergonomic solutions vary from one industry to another, OSHA has provided both general and industry-specific training to its compliance officers. Currently, the OSHA Training Institute (OTI) in Des Plaines, IL, offers three main ergonomic courses to OSHA compliance staff: Principles of Ergonomics Applied to Work-Related Musculoskeletal and Nerve Disorders (#225); Ergonomics Compliance (#325), an advanced ergonomics course; and Nursing Home Enforcement Training (#840). A fourth course, Healthcare (#336), has been in development and will be piloted on November 14, 2000 through November 17, 2000. That course will be designed to help OSHA compliance officers, as well as employers, to identify ergonomic and other hazards within healthcare facilities, with a specific emphasis on hospitals. Over 600 OSHA compliance staff members have been trained in these courses within the past three years alone. The courses typically cover three weeks of material.

Currently, the Principles of Ergonomics Applied to Work-Related Musculoskeletal and Nerve Disorders course also is open to the public through OTI's 12 Regional Education Centers throughout the United States. Since that course has been available nationwide, public interest has been high, and the Education Centers have been scheduling courses on a regular basis to meet the constant demand. Although the new Healthcare Course is available currently only to OSHA compliance officers, after the pilot period ends it will be open to the public on a limited basis.

In addition to education and training opportunities, OSHA has appointed one Regional Ergonomics Coordinator in each of OSHA's 10 regional offices, and one Area Office Ergonomics Coordinator in each area office. These coordinators meet on a monthly basis to discuss recent inspections, case developments, and scientific literature on ergonomics; to share knowledge of ergonomic solutions; and to ensure that enforcement resources are provided to compliance staff for enforcement. A PhD level, professionally certified ergonomist serves as the National Ergonomics Enforcement Coordinator in OSHA's Directorate of Compliance Programs.

4. Corporate-Wide Settlement Agreements

Among the companies that have been cited for MSD hazards, 13 companies covering 198 facilities agreed to enter into corporate-wide settlement agreements with OSHA. These agreements were primarily in the meat processing and auto assembly industries, but there also were agreements with telecommunications, textile, grocery warehousing, and paper companies. As part of these settlement agreements, the companies agreed to develop ergonomics programs based on OSHA's *Meatpacking Guidelines* (Ex. 2–13) and to submit information on the progress of their programs.

OSHA held a workshop in March 1999, in which 10 companies described their experience under their settlement agreement and with their ergonomics programs. All the companies that reported results to OSHA showed a substantially lower severity rate for MSDs since implementing their programs (Ex. 26–1420). In addition, most companies reported lower workers' compensation costs, as well as higher productivity and product quality. A report from the March 1999 workshop on corporate-wide settlement agreements summarizing the results achieved by the 13 companies involved has been placed in the docket (Ex. 26–1420). Only 5 of the 13 companies consistently reported the number of MSD cases or MSD case rates. All five companies that reported data on MSD-related lost workday rates showed a significant decline in the number of lost workdays. None of the companies that reported severity statistics showed an increase in lost workdays as a result of the ergonomics program.

Similarly, the success of OSHA enforcement coupled with settlements requiring comprehensive ergonomics programs was confirmed by the United Food and Commercial Workers International Union. The union recognized that ''* * * [t]he majority of our successful programs in the meatpacking and poultry industries were propelled by OSHA enforcement. Ergonomic settlement agreements and corporate-wide settlement agreements (CWSAs) * * * demonstrate industry recognition of the existence of MSD hazards and the elements of a program to prevent worker injuries arising from exposure to these hazards'' (Ex. 32–210–2, p. 5). The UFCW confirmed the efficacy of these agreements and resulting programs through a number of examples. One was that of IBP's Dakota City meatpacking plant that implemented a comprehensive program as a result of citations and subsequent settlement agreement. Cost savings attributed to the program ''* * * were realized in the following areas: [employee] turnover was down significantly * * *; [MSD] incidence dropped dramatically; surgeries fell; [and] workers' compensation costs were reduced significantly'' (*id.* at 9).

C. Summary

As this review of OSHA's activities in the last 20 years shows, the Agency has considerable experience in addressing ergonomics issues. OSHA also has used all of the tools authorized by the Act—enforcement, consultation, training and education, compliance assistance, the Voluntary Protection Programs, and the issuance of voluntary guidelines—to encourage employers to address musculoskeletal disorders, the single largest occupational safety and health problem in the United States today. These efforts, and the voluntary efforts of employers and employees, have led to the recent 5-year decline in the number of reported lost workday ergonomics injuries. However, in 1997, there were still more than 626,000 lost workday MSD injuries and illnesses reported.

Promulgation of an ergonomics program standard will add the only tool the Agency has so far not deployed against this hazard—a mandatory standard—to these other OSHA and employer-driven initiatives. Over the first 10 years of the standard's implementation, OSHA predicts that more than 3 million lost workday musculoskeletal disorders will be prevented in general industry. Ergonomics programs can lead directly to improved product quality by reducing errors and rejection rates. In an OSHA survey of more than 3,000 employers, 17 percent with ergonomics programs reported that their programs had improved product quality. In addition, a large number of case studies reported in the literature describe quality improvements. Thus, in addition to better safety and health for workers, the standard will save employers money, improve product quality, and reduce employee turnover and absenteeism.

Section III. Legal Authority

A. General Criteria for OSH Act Standards

The purpose of the Occupational Safety and Health Act (''OSH Act'') is ''to assure so far as possible every working man and woman in the nation safe and healthful working conditions and to preserve our human resources.'' 29 U.S.C. 651(b). To further this goal, Congress authorized the Secretary of Labor to promulgate and enforce occupational safety and health standards. Section 6(b) of the OSH Act, 29 U.S.C. 655(b) (authorizing promulgation of standards pursuant to notice and comment); 654(b) (requiring employers to comply with OSH Act standards). This standard is being issued pursuant to section 6(b).

The OSH Act defines an ''occupational safety and health standard'' as ''a standard which requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment.'' Section 3(8) of the Act, 29 U.S.C. 652(8).

A standard is ''reasonably necessary or appropriate'' within the meaning of section 3(8) if it (1) substantially reduces or eliminates a significant risk of material impairment to worker health, safety, or functional capacity; (2) is technologically and economically feasible to implement; (3) is cost effective; (4) is consistent with prior agency action or supported by a reasoned justification for departing from prior agency action; (5) is supported by substantial evidence; and (6) is at least as protective as any applicable national consensus standard. 58 FR 16612, 16614 (March 30, 1993). To fulfill the congressional purpose underlying the Act, all OSH Act standards must be highly protective. Id. at 16614–15.

OSHA's determination that a particular level of risk is ''significant'' is based largely on policy considerations. *See Industrial Union Dep't, AFL–CIO* v. *Marshall,* 448 U.S. 607, 656 n. 62 (1980) (Benzene). The factors that enter into such a determination include the seriousness of the injuries or illnesses a standard will prevent, the likelihood that a particular employee will contract such an injury or illness, and the total number of employees affected. Where the standard seeks to prevent fatal illnesses and injuries, OSHA has generally considered an excess risk of 1 death per 1000 workers over a 45-year working lifetime as clearly representing a significant risk. See Benzene, 448 U.S. at 646; *UAW* v. *Pendergrass,* 878 F.2d 389, 393 (D.C. Cir. 1989) (Formaldehyde); *Building & Constr. Trades Dep't* v. *Brock,* 838 F.2d 1258, 1264 (D.C. Cir. 1988) (Asbestos). But nonfatal injuries and illnesses are often disabling and debilitating, and death is clearly not a precondition to a finding of significant risk of material impairment. *See American Textile Mfrs. Inst.* v. *Donovan,* 452 U.S. 490, 506 n. 25 (1981) (Cotton Dust) (upholding OSHA's finding that cotton dust exposure at levels that caused chronic and irreversible pulmonary disease presented a significant risk to workers); *AFL–CIO* v. *OSHA,* 965 F.2d 962, 975 (11th Cir. 1992) (upholding OSHA's finding that ''there is a level at which [sensory] irritation becomes so severe that employee health and job performance are seriously threatened.''); Formaldehyde, 878 F.2d at 396–399 (upholding OSHA's finding that exposure limit of 1 ppm would eliminate significant risk of sensory irritation due to formaldehyde exposure); *United Steelworkers* v. *Marshall,* 647 F.2d 1189, 1245–51 (D.C. Cir. 1980), cert. denied, 453 U.S. 913 (1981) (Lead I) (upholding OSHA's determination that it was appropriate and necessary to lower lead exposures to reduce cases in which workers experience subclinical effects of lead exposure because such subclinical effects are precursors of serious, lead-related disease); *Forging Indus. Ass'n* v. *Secretary of Labor,* 773 F.2d 1436, 1444–46 (4th Cir. 1985) (en banc) (Noise) (upholding OSHA's significant risk finding that a substantial percentage of workers exposed to existing workplace noise levels would suffer material noise-induced hearing loss). See also *American Dental Ass'n* v. *Martin,* 984 F.2d 823, 826 (7th Cir.), cert. denied, 510 U.S. 859 (1993) (Bloodborne Pathogens) (noting that, in addition to causing death, AIDS and Hepatitis B cause protracted pain and disability).

A standard is technologically feasible if the protective measures it requires already exist, can be brought into existence with available technology, or can be created with technology that can reasonably be expected to be developed. See Cotton Dust, 452 U.S. at 513; Lead I, 647 F.2d at 1272; *American Iron & Steel Inst.* v. *OSHA*, 939 F.2d 975, 980 (D.C. Cir. 1991) (Lead II).

A standard is economically feasible if industry can absorb or pass on the costs of compliance without threatening the industry's long-term profitability or competitive structure. See Cotton Dust, 452 U.S. at 530 n. 55; Lead I, 647 F.2d at 1272; Lead II, 939 F.2d at 980.

A standard is cost effective if the protective measures it requires are the least costly of the available alternatives that achieve the same level of protection. Cotton Dust, 453 U.S. at 514 n. 32; *UAW* v. *OSHA*, 37 F.3d 665, 668 (D.C. Cir. 1994) (Lockout/Tagout II).

Within the framework of these principles, OSHA has considerable discretion (''virtually unlimited discretion,'' in the words of the Lead I decision, 647 F.2d at 1230) in choosing the measures that are reasonably necessary or appropriate to reduce significant risk. A standard may address the hazards associated with an industry (*e.g.*, logging, 29 CFR 1910.266), a kind of work (*e.g.*, hazardous waste cleanup, 29 CFR 1910.120), a category of equipment (*e.g.*, respirators, 29 CFR 1910.134); an environmental area (*e.g.*, confined spaces, 29 CFR 1910.146), a lack of information (*e.g.*, hazard communication, 29 CFR 1910.1200), a class of harmful agents (*e.g.*, bloodborne pathogens, 29 CFR 1910.1030), or may require general measures reasonably necessary and appropriate for safety (*e.g.*, safety and health programs for construction, 29 CFR 1926.20(b)). Depending on the nature of the safety and health issues, some standards require highly specific control measures. *E.g.*, 29 CFR 1926.652 (excavations). Others require the employer to conduct a hazard assessment and establish measures meant to address the problems found. *E.g.*, 29 CFR 1910.119 (process safety management). A typical standard for a toxic chemical will contain permissible exposure limits, a control hierarchy for reaching those limits, and provisions for assessing exposure, medical examinations, medical removal, and training. *E.g.*, 29 CFR 1910.1025 (lead). Some toxic chemical standards also mandate specific work practices that must be used to control exposures. *E.g.*, 29 CFR 1910.1029 (coke oven emissions); 29 CFR 1926.1101 (asbestos). Vaccination against Hepatitis B is one of the protective measures required by the bloodborne pathogens standard, 29 CFR 1910.1030. Medical removal protection benefits have been mandated when they are needed to encourage employees to participate in medical surveillance. 29 CFR 1910.1025 (lead); 29 CFR 1910.1027 (cadmium); 29 CFR 1910.1048 (formaldehyde); 29 CFR 1910.1052 (methylene chloride). Job hazard analysis and employee training are cornerstones of some OSHA standards. *E.g.*, 29 CFR 1910.147 (lockout/tagout).

Section 6(b)(7) of the Act, 29 U.S.C. 665(b)(7), requires standards to include provisions warning employees of hazards, the means needed to protect themselves against those hazards, and, where appropriate, medical examinations or tests to determine whether the health of employees has been adversely affected:

> Any standard promulgated under this subsection shall prescribe the use of labels or other appropriate forms of warning as are necessary to insure that employees are apprised of all hazards to which they are exposed, relevant symptoms and appropriate emergency treatment, and proper conditions and precautions of safe use or exposure. Where appropriate, such standard shall also prescribe suitable protective equipment and control or technological procedures to be used in connection with such hazards and shall provide for monitoring or measuring employee exposure at such locations, and in such manner as may be necessary for the protection of employees. In addition, where appropriate, any such standard shall prescribe the type and frequency of medical examinations or other tests which shall be made available, by the employer or at his cost, to employees exposed to such hazards in order to most effectively determine whether the health of such employees is adversely affected by such exposure.

B. Section 6(b)(5)

Standards dealing with ''toxic materials or harmful physical agents'' must, in addition to meeting the ''reasonably necessary or appropriate'' test of section 3(8), conform to section 6(b)(5) of the Act, 29 U.S.C. 655(b)(5). That section provides:

> The Secretary, in promulgating standards dealing with toxic materials or harmful physical agents under this subsection, shall set the standard which most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life.

The standards that are governed by section 6(b)(5) are sometimes referred to as ''health'' standards, while non-6(b)(5) standards are often referred to as ''safety'' standards. In enacting section 6(b)(5), Congress recognized ''that there were special problems in regulating health risks as opposed to safety risks. In the latter case, the risks are generally immediate or obvious, while in the former, the risks may not be evident until a worker has been exposed for long periods of time to particular substances. It was to ensure that the Secretary took account of these long-term risks that Congress enacted § 6(b)(5).'' Benzene, 448 U.S. at 649 n. 54. According to its legislative sponsor, section 6(b)(5) is intended to require OSHA to take into account the potential that an employee may be exposed to the hazard for his entire working lifetime ''so that we can get at something which might not be toxic now, if he works in it a very short time, but if he works in it the rest of his life it might be very dangerous.'' (Remarks of Senator Dominick in colloquy with Senator Williams, Leg. Hist. at 503).

Section 6(b)(5) directs OSHA to set the standard which will, to the extent feasible, protect employees from material impairment to their health even if they are exposed regularly to the toxic chemical or harmful physical agent for their entire working life. Section 6(b)(5) thus requires that any standard governed by that section must reduce significant risk to the lowest feasible level. See Cotton Dust, 452 U.S. at 509. Safety standards, which are not governed by section 6(b)(5), need not reduce significant risk to the lowest feasible level but must provide a high degree of employee protection to be consistent with the purpose of the Act. 58 FR at 16614–15. Safety standards may therefore ''deviate only modestly from the stringency required by § 6(b)(5) for health standards.'' Lockout/Tagout II, 37 F.3d at 669.

The most important consideration in construing the scope of section 6(b)(5), as with any statutory provision, is the language of the statute itself. In many cases, it is obvious whether a hazard is a ''toxic material'' or ''harmful physical agent'' subject to section 6(b)(5). Other hazards are less clear cut. OSHA has looked to several factors in determining whether a standard fits within section 6(b)(5). These include: Is the hazard likely to cause harm promptly or after a short period of exposure, or does harm occur only after a lengthy period of exposure? Is the connection between exposure and harm apparent, or is it hidden and subtle? Is the harm coincident with exposure, or is there a latency period with harm frequently manifesting itself long after exposure has ended? See Benzene, 448 U.S. at 649 n. 54; *UAW* v. *OSHA*, 938 F.2d 1310, 1313 (D.C. Cir. 1991) (Lockout/Tagout I); *National Grain & Feed Ass'n* v. *OSHA*, 866 F.2d 717, 733 (5th Cir. 1989) (Grain Dust).

Because the hazardous exposures regulated by this standard cannot be neatly categorized by the factors discussed above, whether this standard is governed by section 6(b)(5) poses difficult legal issues. Some commenters supported characterizing the rule as a section 6(b)(5) rule (Ex. 32–339–1 at p. 15 (AFL–CIO), while others opposed it. Ex. 32–368–1 at p. 41–44 (National Coalition on Ergonomics); Ex. 32–206–1 at p. 32 (American Iron & Steel Institute); Ex. 22–337–1 at pp. 3–7 (Integrated Waste Service Association); Ex. 30–1722 at pp. 33–35 (Chamber of Commerce). For a variety of reasons, OSHA concludes that the standard is not subject to section 6(b)(5).

First, the language of the statute itself suggests that this rule is not governed by section 6(b)(5). That provision applies to ''toxic materials or harmful physical agents.'' The ''toxic materials'' to which section 6(b)(5) refers include chemicals that are harmful if breathed and/or ingested, such as asbestos, lead, and mercury. S. Rep. No. 91–1282, 91st Cong., 2d Sess. at 2, reprinted in Committee Print, Legislative History of the Occupational Safety and Health Act of 1970, (Leg. Hist.) at 142. Ergonomic risk factors are clearly not a toxic material. The ''harmful physical agents'' to which Congress referred include laser radiation, ultrasonic energy, ionizing radiation, noise, and vibration. Id. at 142–43. Of the harmful physical agents mentioned by Congress, only vibration is a risk factor addressed by the ergonomics standard. The remaining risk factors addressed by this standard—force, repetition, awkward postures, and contact stress—-are fundamentally dissimilar from the harmful physical agents discussed by Congress in that they relate to the position, movement, and loading on the tissues of a worker's body rather than an external agent acting on the body. See *Pulaski* v. *California Occupational Safety & Health Standards Board*, 90 Cal. Rptr. 2d 54, 66 (Cal. Ct. App. 1999) (''a repetitive motion injury is neither a 'toxic material' nor a 'harmful physical agent.' ''). Therefore, the language and legislative history of the Act indicate that the majority of the risk factors addressed by this rule are not the type of hazards Congress intended to regulate under section 6(b)(5).

In addition, the hazards addressed by the rule differ from those addressed by section 6(b)(5). A lengthy period of exposure—years, decades, or a working lifetime—is not necessary to create a substantial risk of MSDs. As discussed below, both acute and chronic exposures to ergonomic risk factors can result in MSDs. And, although MSDs frequently develop gradually as a result of exposure over time, the period of time necessary can be days, weeks, or months, rather than the working lifetime referred to in the text of section 6(b)(5). Moreover, MSDs are unlike illnesses, such as cancer, damage to the reproductive system, and kidney failure, that can result from exposure to toxic chemicals and appear long after the exposure ceased even though the exposure caused no overt symptoms while it was occurring. An employee who is beginning to suffer a work-related MSD will frequently recover fully after the exposure to ergonomic risk factors ceases. For that reason, the standard requires that an employee who develops a work-related MSD be restricted from participating in work activities or removed from exposure that will worsen the condition.

The ability of employers and employees to generally recognize a cause-and-effect relationship between ergonomic risk factors and many MSDs also indicates that this final standard is a non-6(b)(5) rule. In recent years, as both employers and employees have become more aware of the connection between workplace risk factors and MSDs (see Tr. 5817–19), employers have reported over 600,000 work-related MSDs that result in lost workdays each year (64 FR at 65931). Employees themselves are often able to recognize when MSDs result from exposure to risk factors in the workplace. As OSHA noted in the proposal: ''Many employers have told OSHA that talking with employees is a quick and easy way to find out what kind of problems are in the job. They said that talking with employees is often the best way to identify the causes of the problem and to identify the most cost-effective solutions to it.'' 64 FR at 65805 (citing Ex. 26–1370). Testimony at the public hearing made the same point. Dr. Suzanne Rodgers, a physiologist with 32 years' experience in industrial ergonomics, testified that the companies she had worked with learn about ergonomic problems by having employees tell them when a problem exists. (Tr. 2144). Similarly, David Alexander, a certified professional ergonomist with more than 25 years experience, testified that encouraging employees to report early signs and symptoms of developing MSDs was a key feature of a successful ergonomics program. (Tr. 2145–46).

Further, Congress provided for special treatment of health hazards in section 6(b)(5) because it recognized that employers had little incentive to control exposures to toxic chemicals and harmful physical agents when there is a long period between exposure to a hazard and the manifestation of an illness. ''In such instances a particular employer has no economic incentive to invest in current precautions, not even in the reduction of workmen's compensation costs, because he seldom will have to pay for the consequences of his own neglect.'' Leg. Hist. at 144. However, in this respect too, the ergonomics standard is more like a typical safety standard than a health standard because many of the costs of such injuries in terms of workers' compensation claims and lost productivity are borne by employers as MSDs occur. Thus, the ergonomics standard does not implicate section 6(b)(5)'s concern about hazardous exposures that lead to illnesses after lengthy exposure and therefore require special attention because employers can defer or avoid the costs associated with such illnesses.

Finally, the type of information on which this standard is based is far more characteristic of a safety standard than a section 6(b)(5) health standard. The risk assessment for this standard, as for a typical safety standard, is based on the number of injuries that have resulted from past exposures to the hazard being regulated and the percentage of those injuries that are preventable. By contrast, for a typical health standard, the risk assessment is based on mathematical projections to determine the significance of the risk at various levels of exposure. See, *e.g.,* Formaldehyde, 878 F.2d at 392–96 (discussing OSHA's quantitative risk assessment for formaldehyde exposure). In the proposal, OSHA recognized that the risk assessment methodology for this standard was similar to that for a safety standard rather than a typical health standard:

> There is no need, in the case of musculoskeletal disorders, for OSHA to engage in risk modeling, low-dose extrapolation, or other techniques of projecting theoretical risk to identify the magnitude of the risk confronting workers exposed to ergonomic risk factors. The evidence of significant risk is apparent in the annual toll reported by the Bureau of Labor Statistics, the vast amount of medical and indemnity payments being made to injured workers and others every year * * * and the lost production to the U.S. economy imposed by these disorders.

64 FR at 65979.

In the NPRM, OSHA preliminarily concluded that the proposed ergonomics standard was a section 6(b)(5) standard. The NPRM stated that MSDs are caused by chronic and not by short-term exposures. 64 FR at 66057. Some commenters contended that this statement was inconsistent with OSHA's proposed definition of MSD and the inclusion of ''traumatic'' injuries in its risk assessment. Ex. 22–337–1 at p. 7 (Integrated Waste Service Association); Ex. 32–241–4 at pp. 197–99 (Anheuser-Busch & United Parcel Service); Ex. 32–300–1 at pp. 15–16 (Edison Electric Institute). The proposed definition of MSD included musculoskeletal disorders other than those caused by accidents and was intended to include, *e.g.,* back injuries caused by lifting (for employees for whom manual handling is a core job element) without regard to whether the injury resulted from a particular exertion or the cumulative effect of numerous lifting exertions. As OSHA elsewhere explained:

> The pathogenesis of work-related MSDs can refer to either single, point-in-time injuries, associated with work tasks that result in activities in which tissue tolerance is acutely exceeded, or circumstances in which the performance of specific work tasks or combinations in which the performance of specific work tasks or combinations of tasks over a prolonged period of time result in small and repeated tissue damage.

64 FR at 65900.

Moreover, the BLS injury and illness data on which OSHA based its proposed risk assessment (see 64 FR at 65931, Table VI–3) indicates that many of the injuries considered MSDs resulted from short-term rather than chronic exposures. OSHA has reexamined its reasoning in light of these comments and agrees that the acute-chronic distinction it drew in the proposal is inappropriate when describing MSDs and therefore does not afford a proper basis for classifying this rule as a section 6(b)(5) standard.

As discussed in more detail in the risk assessment section, the injury and illness data reported by BLS categorizes each incident by type of injury or illness and the nature of the exposure event leading to the injury or illness (BLS 1992, Ex. 26–1372). Under the BLS data collection system, employers are instructed to report musculoskeletal injuries and illnesses under various codes, some of which represent musculoskeletal system and connective tissue diseases and disorders that result from repetitive activity and some of which represent other types of exposure events. The BLS category that accounts for most of the reported injuries and illnesses, 021, includes sprains, strains, and tears of muscles, joints, tendons, and ligaments. The category is described as representing traumatic injuries, which generally result from a single event or exposure. Ex. 26–1372 (BLS Occupational Injury and Illness Classification Manual).

In its preliminary risk assessment, the agency closely examined the BLS data, excluded from its analysis injuries caused by accidents (*i.e.,* slips, trips, falls, and being struck by objects), and included those codes that predominantly represented work-related MSDs, including 021, that were reported under the exposure event categories most closely representing ergonomic risk factors. 64 FR at 65928. The largest number of these injuries were classified under the exposure category for ''overexertion,'' which includes primarily lifting, lowering, pushing, pulling, and carrying. 64 FR at 65932. OSHA has followed this same approach in its final rule and in the supporting risk assessment, *i.e.,* excluding musculoskeletal injuries due to accidents but including those resulting from ergonomic risk factors. In OSHA's view, when MSDs result from exposure to ergonomic risk factors, any distinction between acute and chronic exposures is unimportant. OSHA notes that the classification of these disorders as traumatic is in part a convention of the recordkeeping system. OSHA's general recordkeeping guidelines for back disorders instruct that because the specific event causing such a disorder cannot always be pinpointed, to keep recordkeeping determinations as simple and equitable as possible, all back disorders should be classified as (traumatic) injuries rather than (cumulative exposure) illnesses. BLS, Recordkeeping Guidelines for Occupational Injuries and Illnesses (April 1986), at p. 38. Similarly, OSHA's Ergonomics Program Management for Meatpacking Plants states that all back cases are to be classified as injuries even though some back conditions may be triggered by an instantaneous event and others develop as a result of repeated trauma. Ex. 32–210–2–2 at p. 14. Moreover, a number of experts testified in the hearings that a substantial part of the MSD injuries classified under the BLS system as traumatic in fact represent cumulative exposure. (Tr. 2175–77; 2236–44; 5802–04). In short, even though an MSD may be classified as ''traumatic'' in origin, it will often be the case that, while the onset of the injury was sudden, the cause was exposure to ergonomic risk factors over some period of time. However, it is neither necessary nor meaningful to limit the standard's reach to MSDs that only occur because of exposures that take place over some period of time. The purpose of this standard is to reduce the number and severity of MSDs by protecting workers against excessive exposure to ergonomic risk factors and MSD hazards, and for that purpose it is irrelevant whether those excessive exposures are ''acute'' or ''chronic.''

On reflection, OSHA has determined that other considerations relied on in the NPRM are likewise unpersuasive. Although the standard protects against one risk factor—vibration—that qualifies as a ''harmful physical agent,'' OSHA does not believe that factor alone makes this a section 6(b)(5) standard. The standard is not a ''vibration'' standard but one that addresses the multifactorial causes of MSDs. The risk factors that are not ''harmful physical agents''—force, repetition, awkward posture, and contact stress—together contribute substantially more to the vast majority of MSDs than does vibration.

Similarly, that a provision in OSHA's standard governing access to employee exposure and medical records (29 CFR 1910.1020(c)(13)) defines ''toxic substance or harmful physical agent'' as including ''repetitive motion'' does not establish that repetitive motion is a harmful physical agent within the meaning of section 6(b)(5). See Ex. 32–339–1 at p. 15 (AFL–CIO). Whether repetitive motion is a harmful physical agent was not central to that rulemaking, which dealt with the access of employees and OSHA personnel to employee records and did not regulate particular hazards. In that rulemaking, interested parties had no reason to argue whether a standard that regulates repetitive motion is a section 6(b)(5) standard, and OSHA had no occasion to address that issue. Moreover, the records access rule was not issued under section 6(b)(5) but under OSHA's general authority to issue standards (section 6(b)) and regulations (section 8(g)). And it was upheld in court as a section 8(g) regulation rather than a section 6(b) standard. *Louisiana Chem. Ass'n* v. *Bingham,* 731 F.2d 280 (5th Cir. 1984), aff'g 550 F. Supp. 1136 (W.D. La. 1982). Therefore, the fact that the records access rule applies to repetitive motion cannot be regarded as establishing an OSHA policy that repetitive motion is a harmful physical agent for purposes of section 6(b)(5).

C. This Final Rule Does Not Regulate non-Workplace Activities

Some commenters have pointed out that MSDs can result from personal activities as well as from workplace exposures. Ex. 32–368–1 at p. 40 (National Coalition on Ergonomics); Ex. 32–241–4 at p. 49 (Anheuser-Busch & United Parcel Service). They argue that OSHA is attempting through this rule to regulate the nonwork activities that may contribute to MSDs and that the rule is therefore outside OSHA's authority. However, the rule regulates only conditions or activities in workplaces, and OSHA clearly has the authority to issue the rule.

Many adverse health conditions can be caused or aggravated by both work and nonwork exposures. For example, exposures to high noise levels both inside and outside the workplace can contribute to a worker's hearing loss. Nevertheless, OSHA has the authority to regulate harmful noise levels in the workplace as long as the workplace exposures create a significant risk of material impairment of health. *Forging Indus. Ass'n* v. *Secretary of Labor,* 773 F.2d 1436, 1442 (4th Cir. 1985) (en banc) (Noise).

Noise dealt with a challenge to the Hearing Conservation Amendment to OSHA's occupational noise standard. That amendment establishes certain requirements that must be met to reduce the incidence of and/or prevent hearing impairment due to occupational noise exposure. Before issuing the amendment, OSHA found that 10–15% of workers exposed to noise levels below the permissible exposure limit (PEL) would suffer material hearing impairment. 773 F.2d at 1443. OSHA based this finding on a ''panoply of scientific reports and studies,'' including studies done by the National Institute for Occupational Safety and Health (NIOSH) and the Environmental Protection Agency (EPA). *Id.* OSHA also found that those employees who had suffered a hearing decrement of 10 decibels in either ear faced a greater risk from continued exposure to high levels of workplace noise than workers whose hearing was unimpaired. Id. OSHA's Hearing Conservation Amendment provided hearing-endangered workers with protection in the workplace in order to decrease the risk of hearing impairment.

The Forging Industry Association (FIA) argued that ''because hearing loss may be sustained as a result of activities which take place outside the workplace—such as listening to loud music, age, or engaging in certain recreational activities—OSHA acted beyond its statutory authority by regulating non-occupational conditions or causes.'' Noise, 773 F.2d at 1442. The court found ''no merit'' in FIA's argument. The court ruled that OSHA properly relied on ''the extensive and thorough research of several scientific institutions in defining the problems related to industrially-caused hearing loss in designing its proposal.'' Id. at 1443. The court also stressed that OSHA excluded non-occupational hearing loss from the rule. Id. at 1444 (''To be sure, some hearing loss occurs as a part of the aging process and can vary according to non-occupational noise to which employees are exposed. The amendment, however, is concerned with occupational noise—a hazard of the workplace.''). The court ruled that the fact that non-occupational hazards may contribute to hearing loss does not mean that OSHA should refrain from regulating workplace conditions that are shown to cause such loss:

The amendment provides that non-occupationally caused hearing loss be excluded from its regulation. See 29 CFR 1910.95(g)(8)(ii), 1910.95(g)(10)(ii) (1984). Assuming, however, that some loss caused by aging or smaller amounts of noise sustained for shorter periods also aggravates the hearing loss incurred by an individual employed in a high noise-producing industry, that is scant reason to characterize the primary risk factor as non-occupational. Breathing automobile exhaust and general air pollution, for example, is damaging to lungs, whether healthy or not. The presence of unhealthy lungs in the workplace, however, hardly justifies failure to regulate noxious workplace fumes. Nor would there be logic to characterizing regulation of the fumes as non-occupational because the condition inflicted is aggravated by outside irritants.

Noise, 773 F.2d at 1444.

Like the Hearing Conservation Amendment to the Noise standard, this final ergonomics rule regulates workplace hazards. As discussed in the health effects section of this preamble, this rule addresses only exposure to ergonomic risk factors that occurs in the workplace. The MSDs that trigger action under the rule must be work-related and they must have occurred in workers whose jobs place them at a heightened risk of incurring a MSD because they are exposed to risk factors at the levels in the Basic Screening Tool.

A decision by the Occupational Safety and Health Review Commission supports OSHA's conclusion that the Act can properly address work-related ergonomic hazards even though employees can also be exposed to such hazards outside the workplace. In Pepperidge Farm, Inc., 17 O.S.H. Cas. (BNA) 1993 (1997), the Commission held that where work was shown to be a substantial contributing factor to MSDs, the fact that non-work factors may also play a role did not preclude OSHA from requiring the employer to abate the workplace hazards. In that case, Pepperidge Farm contested a number of citations for ergonomic violations that OSHA had issued under section 5(a)(1) of the Act. In order to prove a section 5(a)(1) violation, OSHA had to show that a condition or activity in the employer's workplace presents a ''hazard to employees.'' 17 O.S.H. Cas. (BNA) at 2009 (emphasis added). The company argued that section 5(a)(1) should not apply to MSD workplace hazards because, among other things, ''non-workplace factors may cause or contribute to the illnesses at issue and that individuals differ in their susceptibility to potential causal factors.'' Id. at 2013. The Commission held that such factors should not ''ipso facto'' preclude the possibility of enforcement under section 5(a)(1). Id. The Commission also analyzed a significant amount of evidence that showed a causal relationship between MSDs and workplace hazards, including testimony from medical personnel who examined injured workers, epidemiological data, and injury incidence at a Pepperidge Farm plant. Id. at 2020–26. The Commission ultimately found that there was a causal connection:

We therefore conclude that the Secretary has established on this record a causal connection between [MSDs] affecting the employees at Downington [a Pepperidge Farm plant] and their work on the biscuit lines. In doing so, we are mindful that many of these injuries may have had more than one causal factor and of the experts who contend that the specific cause of such injuries is, essentially, unknowable or presently unknown. As is the case with many occupational ills with multiple possible causes, employees are more or less susceptible to injury on the job because of the individual attributes and backgrounds they bring to the workplace. As with these other ills, the Secretary is not thus foreclosed from attempting to eliminate or significantly reduce the hazard by regulating what is shown to be a substantial contributing factor to the worker injuries.

17 O.S.H. Cas. (BNA) at 2029.

The Commission's holding in Pepperidge Farm that the susceptibility of some employees to a particular ailment does not preclude OSHA from regulating workplace conditions or practices that cause or contribute to that type of ailment is supported by other cases. In the asbestos rulemaking, OSHA based its significant risk determination, in part, on epidemiologic studies that included workers who smoked and were therefore significantly more likely to contract cancer than those who did not. Asbestos, 838 F.2d at 1265. The court held that OSHA was justified in doing so. Smokers were not, the court said, ''so far beyond the pale as to *require* OSHA to ignore them in computing the risks of asbestos.'' Id. (emphasis added). See also *Reich* v. *Arcadian Corp.*, 110 F.3d 1192, 1198 (5th Cir. 1997) (Congress intended Act's general duty clause to protect all employees, including those who are especially susceptible). Thus, workers who engage in activities outside the workplace that expose them to ergonomic risk do not thereby forfeit on-the-job protection against exposure to excessive ergonomic risk factors.

IV. Summary and Explanation

(a) What Is the Purpose of This Rule?

The first paragraph of the final standard sets out the purpose of this ergonomics program standard. OSHA did not propose a purpose paragraph, and thus no comments on this topic were received. OSHA has decided to include a purpose statement in the final rule to clearly indicate the goal of the standard and to differentiate between those musculoskeletal disorders (MSDs) that are covered by the standard and those that are not. It clarifies that the standard's purpose is to reduce the number and severity of MSDs that are caused by occupational exposure to ergonomic risk factors (also called ''ergonomic stressors'') on the job.

As discussed in more detail below, the disorders addressed by this rule include those of the muscles, nerves, tendons, ligaments, joints, cartilage, blood vessels, and spinal discs occurring in the neck, shoulder, forearm, wrist, hand, abdomen (hernias only), back, knee, ankle, and foot. They include conditions classified by the Bureau of Labor Statistics in its Annual Survey as illnesses (*e.g.*, carpal tunnel syndrome) and as injuries (*e.g.*, low back pain), because MSDs include many different disorders, affect many tissues and areas of the body, and may be described by a wide range of medical diagnoses.

The terms used to describe this group of conditions have varied over time and geographic region. For example, in Australia, MSDs are often called ''Occupational Overuse Syndrome'' injuries. Other frequently used terms include ''repetitive stress injuries,'' ''cumulative trauma disorders,'' and ''soft tissue injuries.'' In recent years, however, the term ''musculoskeletal disorders'' has gained widespread acceptance by the scientific community, and OSHA uses this term, or its abbreviation, MSD, throughout the regulatory text and supporting analyses.

Paragraph (a) makes explicit that OSHA's ergonomics program standard does not apply to injuries or illnesses caused by motor vehicle accidents, slips, trips, falls, or similar accidents that result in traumatic injuries on the job. By ''other similar accidents,'' OSHA means, for example, caught in or caught between injuries or other accidents resulting in blunt trauma. (Throughout this notice, OSHA uses the terms ''work-related,'' ''caused by,'' ''musculoskeletal disorders,'' ''risk factors,'' and ''exposure.'' For a detailed discussion of these terms, see the relevant sections of the Health Effects (Section V of the preamble), Summary and Explanation (Section XI), and Legal Authority (Section III) sections of this preamble.)

As stated in paragraph (a), the purpose of this standard is to reduce the number and severity of MSDs caused by workplace exposure to ergonomic risk factors, such as force, awkward postures, or repetition, either alone or in combination. The standard requires employers to implement an ergonomics program to address risk factors in jobs that pose an MSD hazard to the employees in those jobs. As discussed in detail in Section VI of the preamble, Risk Assessment, ergonomics programs have been shown to reduce the number and severity of MSDs in old and new facilities, in large and small workplaces, and in a wide variety of jobs ranging from computer use to solid waste handling, from assembly line operations to patient handling, and from beverage distribution to meat processing.

Reducing the number and severity of MSDs in the workplace is the goal of successful ergonomics programs everywhere. As the more detailed discussions in this preamble and in the Agency's economic analysis will show, this goal cannot be achieved overnight, although positive results are generally observed soon after program implementation. One effect of a new ergonomics program, which at first glance may not appear to be a positive one, is that the number of MSDs and MSD signs and symptoms reported in the first months after the implementation of the program may actually increase. This initial increase in the number of MSD reports reflects the heightened awareness of ergonomics, the importance of early reporting, and the value of conservative treatment that routinely accompanies program implementation. In most workplaces, this increase is short-lived, generally lasting less than a year and almost never more than two years. The severity of the MSDs reported, however, generally decreases in the first few months after program initiation and declines steadily thereafter, before leveling off as the program matures. Thus, OSHA intends and expects the final rule to reduce the number and severity of MSDs in the workplaces covered by the standard over the first few years after the standard is fully in effect; OSHA is aware that the standard's purpose will not be fully achieved in the short run. When ergonomic programs mature, they continue to demonstrate ongoing reductions in the number of MSDs caused by workplace risk factors and in the severity of those MSDs that do occur.

The standard's purpose paragraph also reflects OSHA's awareness that work-related MSDs will continue to occur in many workplaces even after implementation of an effective ergonomics program that complies fully with this final rule. The standard being issued today is thus not a ''zero-risk'' standard. It recognizes that substantially reducing the number and severity of these disorders is possible in most, if not all workplaces, although many establishments may not be able to eliminate MSDs completely. (For a discussion of OSHA's analysis of the standard's projected effectiveness, see the Risk Assessment section of the preamble (Section VI) and Chapter IV, Benefits, of the Final Economic and Regulatory Flexibility Analysis.)

Paragraph (b)—Does This Standard Apply To Me? (Scope and Application)

Discussion of the scope and application of the final rule is divided into three parts. Part I discusses which employers and operations the standard covers. Part II explains the exclusions from coverage of the rule and OSHA's authority to limit the standard's coverage to general industry. Part III addresses other scope and application issues raised during the rulemaking.

Part I—Scope and Application of Standard to General Industry Employers

A. Scope of Coverage

Paragraph (b) states that the standard applies to general industry employment, which means all employment except for railroads and employment covered by OSHA's agriculture, construction, and maritime standards. Unlike other OSHA general industry standards, however, this standard does not cover general industry work performed incidentally to or in support of construction, maritime, or agricultural employment or railroad operations. This means that functions such as office work, management and support services are not covered by the standard, and that, for example, a construction company office or a marine terminal cafeteria would not be covered. However, a construction company real estate division engaged in selling the finished properties would not be performing functions directly in support of the construction operations and would be within the scope of the standard.

The final rule thus imposes coverage based on the business category in which the employer belongs, *e.g.,* general industry as opposed to construction. This marks a departure from the Agency's past practice of imposing coverage based solely on the job that an employee is performing. The approach adopted in this standard, *i.e.*, basing coverage on the industry classification of the employer, is appropriate here because of the unique nature of ergonomic problems and solutions. The requirement to implement an entire program when an MSD incident occurs in a job that meets the Action Trigger is more practical administratively if employers are required to take this broad approach.

Moreover, the standard does not apply to jobs or operations that are normally covered exclusively by the construction, agriculture and maritime standards, even if those operations are performed in a general industry establishment or for a general industry employer. Thus a construction crew whose sole job is to build in-plant structures in a steel mill is engaged in construction and is not covered by this standard, even though the steel mill itself is a general industry operation. This is consistent with the operation of other OSHA standards.

Although the proposal also applied only in general industry, its scope provision stated that coverage was further limited to general industry manufacturing jobs, manual handling jobs, and jobs with MSDs. Manufacturing jobs were defined as ''production jobs'' in which the activities of producing a product made up a ''significant amount'' of the employee's worktime. Manual handling jobs were those in which the employee performed ''forceful'' lifting (*i.e.*, lifting or lowering, pushing or pulling, or carrying) and the forceful lifting tasks were a ''core element'' of the employee's job. Jobs with MSDs were defined as jobs in which an OSHA recordable MSD occurred in a job in which the physical work activities and conditions were reasonably likely to cause that type of MSD, and the activities were a core element of the job or accounted for a significant amount of the employee's worktime (64 FR 65779–82).

The proposal explained that OSHA was focusing on general industry in this first ergonomics rulemaking because the problems in general industry are particularly severe and the solutions are well-understood (64 FR 65776). Some commenters agreed with the proposed rule's scope, and its emphasis on manufacturing and manual handling jobs (Exs. 31–3, 31–71, 31–180, 31–252, 31–284, 32–300). More, however, argued either that the rule should not exempt construction, maritime and agricultural employment (Exs. 30–400, 30–1294, 31–14, 31–105, 31-143, 31–156, 31–345, 31–352, 32–198–4, 32–210, 32–359–1, 32–461–1, 30–1294, 500–218), or that the rule should exempt even more industries or jobs (Exs. 30–372, 30–494, 1–248, 31–280, 32–77-2, 32–78, 32–234, 30–2208, 30–3167, 32–77–2, 601–X–1, Tr. 3126).

Many of the commenters who believed that the scope of the proposed rule was too broad argued that it incorporated a ''one size fits all'' approach that was inappropriate for the wide variety of operations found in general industry (Ex. 30–494, see also Exs. 30–380, 30–372, 30–531, 30–3167, Tr. 3126, 3332). Some of these commenters pointed out that there was great variation in MSD rates, prevalence of ergonomic risk factors, and levels of exposure to those risk factors across general industry (Exs. 30–541, 30–3167). Others pointed out that jobs differed greatly within and across industries, and claimed that OSHA did not have enough information about effective controls in all industries (Exs. 30–425, 30–3167, 32–77, 32–211–1, 32–2208). The focus of both these groups of comments was that OSHA did not have enough knowledge or evidence to find that the same approach to controlling ergonomic hazards would be appropriate in all of these disparate circumstances.

A number of commenters suggested ways to limit the standard's scope. Some urged OSHA to focus the rule more narrowly on those jobs or industries with the highest MSD rates or those deemed to have high risk potential (Exs. 30–13, 30–425, 30–2208, 30–3167, 31–248, 31-280, 32–78, 32–234, Tr. 2729–30). For example, Larry Leahy of Ruth Constant & Associates, a home health care service agency, questioned why OSHA was covering all of general industry when 60 percent of the MSDs occurred in industries representing a fairly small percentage of the national workforce (Ex. 30–611). Todd McCracken, of National Small Business United, argued:

> There is a need to focus on particular types of jobs . . . There are specific types of jobs in specific industries where MSDs are much more likely to occur (Tr. 2729–30).

Similarly, Organization Resources Counselors, Inc. (ORC) recommended that the rule only cover high risk occupations or employers whose MSD incident rates were above the national background level (Ex. 32–78; see also Tr. 10633–35). The Small Business Administration's Office of Advocacy suggested covering only manual handling jobs, which it claimed accounted for 78 percent of all MSDs (Ex. 601–X–1).

As discussed in detail throughout this preamble, OSHA believes that the record supports coverage of all of general industry within the overall scope of the standard. The final standard does not, however, prescribe a one-size-fits-all solution for a wide range of problems in diverse jobs and industries. Even in those situations where significant ergonomic hazards exist, the commonality of the response required by this standard is to implement an ergonomics program. The specific focus of that program will be targeted to the particular hazards and conditions at each workplace. The control strategies for ergonomic hazards will be targeted even more specifically to the needs of each workplace. And the extent of each employer's compliance obligation will be determined by the extent of the problem at that employer's workplace. Thus the fact that the rule applies to a variety of hazards at differing workplaces does not in any way mean that the employers in all of those workplaces need to take the same actions.

Work-related MSDs are widespread throughout general industry. They occur in every single sector within general industry, according to the Bureau of Labor Statistics (BLS). In 1996, according to BLS, there was no industry sector that did not report the occurrence of at least several hundred work-related MSDs, with a large number of industries reporting tens of thousands of work-related MSDs. Moreover, high concentrations of work-related MSDs are reported in a wide variety of occupations that are found throughout general industry establishments. BLS data for 1996 show that general industry truck drivers, laborers, and janitors, occupations found widely dispersed throughout general industry sectors, experienced more than 48,000, 38,000 and 15,000 lost workday (LWD) MSDs, respectively. (See Section VII (Risk Assessment) of this preamble.)

Evidence submitted by rulemaking participants confirms the broad distribution of MSDs and MSD hazards throughout general industry. For example, the Service Employees International Union (SEIU) submitted evidence that union members working in a variety of health care settings (*e.g.,* hospitals, nursing homes, private homes, pharmacies) have suffered MSDs (Ex. 32–311–1). These health care workers include registered nurses, licensed practical nurses, nurses' aides, orderlies, physical therapists, radiology technicians, housekeepers (maids and housemen), laundry workers, laundry machine operators, maintenance workers, kitchen and food preparation workers, central supply workers, and janitors and cleaners. In addition, SEIU said that other union members such as janitors and cleaners working in a variety of other industries, including hotels/motels, restaurants, offices have also experienced MSDs (Ex. 32–311–1).

At the rulemaking hearing, many employees testified that they had suffered serious work-related MSDs. Occupations in which these employees were working when they became injured include:

- Nurse
- Home health care aide
- Nurses' aide
- Package delivery
- Package sorting
- Meatpacking and poultry processing
- Office clerical worker
- Internet publishing
- Machinists
- Sewing machine operator
- Truck driver
- Food warehousing and distribution
- Grocery store cashier
- Physical therapist
- Mail carrier
- Letter sorter
- Teacher
- Teachers' aide
- Auto assembly
- Molding and casting machine operator
- Reporter
- Grocery shelf stocker
- Sonographer
- Television film editor
- Electrical workers

(Exs. 30–4200, 32–185–3, 32–210–2, 32–198–3, 32–311, 500–218, Tr. 4009–10, 4235, 4240, 4234, 6004, 6009, 6319, 6321–22, 6333, 7320–21, 7335–37, 7341–42, 17950).

Doctors and other health care professionals (HCPs) also testified that they had treated employees in many different jobs and industries for work-related MSDs (Exs. 37–12, 37–28, Tr. 14973, 15045–46, 16819, 16829). Dr. Robert Harrison testified that, in his research and practice, he had diagnosed and treated over 1,000 patients with work-related MSDs from a wide variety of industries and occupations, including (Ex. 37–12):

- Postal workers
- Materials handlers
- Computer operators
- Grocery checkout clerks
- Meat processors
- Assemblers
- Seamstresses
- Telephone operators
- Pipefitters
- Customer service agents
- Machine operators
- Automotive manufacturing workers
- Aircraft manufacturing workers
- Optical scanners
- Graphic artists
- Restaurant workers
- Bakers
- Plumbers
- Letter sorters

Dr. Robin Herbert, the medical co-director of the Mt. Sinai Center for Occupational and Environmental Medicine, testified that she had treated or supervised the treatment of more than 2,000 patients with upper extremity MSDs in the past 12 years:

> My patients have included journalists, computer graphic artists, health care workers, technicians for telephone companies, automobile manufacturing workers, cashiers, garment workers, meat wrappers, dental hygienists, secretaries, and chefs. Industries from which I have seen patients include publishing, journalism, entertainment, manufacturing, health care, transportation, and telecommunications (Ex. 37–28).

Dr. George Piligian, who also works at the Mount Sinai Center, testified about finding and treating MSDs in dancers, musicians, editors, secretaries, telephone operators, sewing machine operators and hospital workers (Tr. 7813–20).

Similarly, insurance companies, employers and trade associations representing the following industries testified about the implementation of ergonomics interventions and programs because work-related MSDs were occurring among workers in the following environments:

- Chemical manufacturing
- Pharmaceutical manufacturing
- Automotive manufacturing
- Automotive repair
- Boat manufacturing
- Textile manufacturing
- Clothing manufacturing
- Printing
- Dental
- Meatpacking
- Electric utility
- Hospitals
- Office workers
- Hotel/motel
- Emergency medical services
- Furniture manufacturing
- Oil and gas drilling
- Moving and storage
- Fabricare
- Nursing homes
- Telephone operation and installation
- Funeral and cemetery
- Insurance
- Solid waste removal and recycling
- Paint manufacturing
- Poultry processing
- Food warehousing and distribution
- Beverage delivery
- Assembly line
- Grocery store
- Retail clothing
- Foundry

(see, *e.g.,* Tr. 3337–9, Tr. 5104, Tr. 8458–8480, Tr. 16553–57).

Finally, several of the ergonomists who appeared as OSHA's expert witnesses, including David Alexander (Ex. 37–7), David Caple (Ex. 37–20), Dennis Mitchell (Ex. 37–11), Maurice Oxenburgh (Ex. 37–24), Suzanne Rodgers (Ex. 37–25), and John Rosecrance (Ex. 37–26), testified that employers in the following different industries had hired them to help reduce the incidence of work-related MSDs among employees:

- Newspaper
- Luggage manufacturing
- Meatpacking
- Packaging
- Papermaking
- Plumbing supply
- Route sales and delivery
- Film products manufacturing
- Hospitals
- Heavy appliance manufacturing
- Automobile manufacturing and subassembly
- Furniture manufacturing
- Paper and pulp products
- Forest products
- Food service
- Clerical
- Electronics
- Clothing and textile manufacturing
- Baking
- Restaurant
- Home and office furniture manufacturing
- Hospitality—hotel/motel
- Fiber manufacturing
- Logistic and supply warehousing
- Telecommunication
- Textile and apparel manufacturing
- Metal forging and cast metals
- Electronics manufacturing
- Health care
- Petroleum
- Electrical manufacturing
- Airline freight handling
- Steel manufacturing
- Fishing
- Aircraft manufacturing
- Gas and electric utility
- Flooring products
- Computer and computer accessory manufacturing
- Plumbing fixtures manufacturing
- Food products manufacturing and processing
- Chemical manufacturing
- Printing
- Waste treatment
- Plastic manufacturing
- Clothing retail
- Power plants
- Research laboratories
- Transportation
- Printing
- Upholstery
- Rubber manufacturing
- Welding
- Mail sorting and delivery
- Transportation
- Electronics
- Medical products manufacturing

All of this evidence supports OSHA's decision to provide the protections of this standard to all general industry employees. On the other hand, OSHA recognizes that there may be some general industry employers with few or no MSD hazards. Until an MSD is reported, the employer's obligation is limited to distributing the information in paragraph (d).

B. Application of Requirements

Unlike the proposal, this final standard does not differentiate among general industry employers. Under the proposal, employers of employees engaged in manufacturing or manual handling would have been required to implement some elements of an ergonomics program whether or not their employees had suffered any MSDs. Other general industry employers would not have had to take any action until a ''covered MSD'' occurred, and a covered MSD was defined differently for them than for manufacturing and manual handling employers (64 FR 65782–84, 65791). In this final standard all general industry employers are required, as specified in paragraph (d), to provide basic information on ergonomics and the standard to their employees. The employer has no further obligation until the employee reports an MSD or the signs or symptoms of an MSD (see paragraph (e)).

OSHA developed its bifurcated proposal because about 60 percent of all reported MSDs occurred in manufacturing and manual handling jobs, even though those jobs accounted for less than 30 percent of general industry employment. Although some commenters agreed that this might justify a focus on manufacturing and manual handling (Ex. 30–4837), very few expressed satisfaction with the proposed approach (Exs. 30–400, 31–78, 32–198, 32–210, 32–461, 500–218, Tr. 3224). Many commenters said that manufacturing and manual handling jobs should not be singled out because MSD hazards were present and MSD rates were high in other jobs and industries (Exs. 30–626, 30–2208, 31–156, 500–218). For example, participants said that there were many MSD hazards and MSDs in ''any job involving regular computer use,'' therefore, programming, journalism, data entry, system administration, accounting, analysis, and insurance jobs should have been included by name (Exs. 30–49, 30–400, 31–3, 31–12, Tr. 2783, 2932). Likewise, other commenters argued that custodians and supermarket employees including cashiers, bakery personnel, baggers and stockers should be treated on par with manufacturing and manual handling jobs because they involved the same hazards (Ex. 31–23, 32–210; see also Exs. 30–400, 31–78, 32–198, 32–210, 32–461, 500–218, Tr. 3224).

Another group of commenters opposed requiring any employers to take any type of action before a work-related MSD is reported (Ex. 30–240, 32–300, 30–542, 601–X–1) on the grounds that it was a ''waste of resources'' to require a basic program for employers with manufacturing and manual handling jobs that have no MSDs (Ex. 30–542). For example, one said:

If an employer is in one of the targeted industries but has not had MSDs, why force the bureaucracy of program implementation upon him or her * * * (Ex. 30–240).

And while some participants found the definitions of manufacturing and manual handling jobs adequate to identify whether a particular job was covered (Exs. 30–3934, 30–4837, 31–38, 31–36, 31–113, 31–173, 31–205, 31–229, 31–347), most disagreed (Exs. 30–5, 30–46, 30–75, 30-293, 30–1722, 30–3032, 30–3853, 31–4, 31–27, 31–92, 31–106, 31–125, 31–135, 31–211, 31–245, 31–246, 32–78, 32–300, 32–337). Many said that the definitions, particularly the definition of manual handling jobs, were too vague (Exs. 30–137, 30–425, 30–1722, 30–3167, 31–77, 31–180, 31–225, 31–227, 31–248, 31–260, 31–342, 32–78, 32–300, 32–337, Tr. 3255–56). For example, one commenter said:

The definitions of manufacturing and manual handling jobs covered by the standard are guaranteed to leave employers as much in the dark as they are now. What constitutes ''forceful'' manual handling? How much force must be involved to be covered? Should the strength capabilities of individual employees be considered? (Ex. 31–211)

Others were concerned that the definitions were too broad and could include any job or ''almost every employer'' (Exs. 31–135, 31–180, 31–342).

Many participants told OSHA that they did not know what the terms used in the definitions (''forceful'' lifting, ''core element,'' and ''significant amount'' of worktime) meant (Exs. 30–46, 30–293, 30–300, 30–3032, 30–3853, 30–4837, 31–187, 31–202, 31–223, 31–260, 31–289, 32–337, Tr. 3337). For example:

How much is significant? 6 hours per 8-hr shift? 4 hours per 8-hr. shift? 2 hours per 8-hr. shift? Or 2 2-hr. periods per 8-hr. shift? (Ex. 30–4837)

Moreover, commenters did not find the examples of manufacturing and manual handling jobs to be of use:

[T]he examples of jobs are not very helpful. A careless reader could conclude that the lists were exhaustive and, not seeing the jobs in this workplace named, decide he had to do nothing. A more thorough reader would note the disclaimer to the effect that ''* * * each job must be considered on the basis of its actual physical work condition * * *'' and correctly conclude that there is no standard against which to compare the actual physical work conditions'' (Ex. 31–211).

(See also Exs. 30–3032, 30–3853, 32–300.)

OSHA is accounting for these concerns in this restructuring of the standard's scope and application provisions. This final rule applies to all general industry employers, but no employer is required to evaluate or implement control measures or MSD management until an MSD incident occurs in a job that involves exposure to risk factors at levels meeting those in the Basic Screening Tool in Table 1. The only obligation employers have until that point is to provide information about ergonomics and the standard to their employees. And, as explained in the discussion of paragraph (d) below, OSHA is providing that information in Appendices A and B and on its website.

OSHA believes that these changes respond to most complaints about the scope and application provisions of the proposal. By eliminating the additional requirements for manufacturing and manual handling employment, OSHA is eliminating both the need to define those terms and much of the complexity and vagueness commenters found in the proposal. By limiting employers' obligations in establishments that have not experienced MSD incidents, OSHA is also taking account of the facts that not all manufacturing and manual handling jobs involve more significant ergonomic hazards than do other general industry jobs, and that some of those other jobs are also hazardous.

The minimal burden in paragraph (d) for all general industry employers to disseminate information is necessary so that employees will know how and when to report MSDs. Given the importance of providing information at the earliest possible point and the minimal burden this requirement will impose, OSHA believes that it is appropriate to apply the initial requirement to all general industry employers. (The issue of the need for information is discussed in more detail below in the summary and explanation on paragraph (d)).

II. Industries/Employment/Operations Excluded From the Final Rule

Like the proposal, the final standard does not cover construction, agriculture, and maritime employment. Although many participants agreed with this exclusion (Exs. 30–3032, 30–3752, 31–68, 31–160, 31–187, 31–207, 31–219, 31–245, 31–252, 31–259, 32–300), a number favored expanding the scope of the rule to cover all industries regulated by OSHA (Exs. 30–400, 30–428, 30–1294, 32–210, 500–218, Tr. 2859, 3224, 5592, 9080, 13445, 113745, 14002, 17362, 17652). Their arguments fell into three categories.

First, many of these commenters pointed to the high number and rate of MSDs, especially back injuries, occurring in industries excluded from the proposed rule (Exs. 30–626, 30–2208, 31–156, 31–183, 31–225, 500–218). The Mount Sinai Center for Occupational and Environmental Medicine Construction Hygiene and Ergonomics Program (CHEP) pointed out that, aside from the transportation industry, construction has the highest rate of back injury of any industry:

Every year 1 in 100 construction workers will miss between 7 and 30 days of work due to back injuries * * * At one surveyed worksite all wallcoverers who had worked 15 years or more in the trade had required surgery or medical intervention for problems including carpal tunnel syndrome, pain in the neck, shoulder and back, and knee problems (Ex. 31–183).

Some commenters also favored expanding coverage because they said that employees in construction, agriculture and maritime are exposed to the same risk factors and MSD hazards as are employees in general industry (Exs. 30–626, 31–22, 31–183, 31–263, 31–303, 500–218). They said there was no reason to distinguish coverage by industries if the rule was also incorporating an MSD trigger because, as one put it, ''[a]n injury is an injury, and I have no doubt there are always ways to handle these jobs just as safely as any others'' (Ex. 31–19).

A number of commenters said that at least jobs in construction, agriculture and maritime that are essentially the same as in general industry, primarily manual handling jobs, should be added to the rule (Exs. 31–14, 31–19, 31–65, 31–98, 31–192, 31–219, 31–307, Tr. 2850–51). For example:

Many jobs, especially manual handling jobs, have similar if not identical hazards to that of general industry. If an employee is performing lifting that requires excessive force it does not matter in which industry he is performing the lifting. The actions to reduce the risk of injury would be similar for each industry (Ex. 31–307).

See also (Ex. 31–19; 31–65).

Another group of participants said that the record contains sufficient evidence on the availability and effectiveness of ergonomic interventions to support expanding the rule to the construction, agriculture and maritime industries (Exs. 31–183, Tr. 2849–51, 7478–80, 7482, 7485, 15761–71, 17540–41, 17561). Members of this group pointed to a number of articles and studies about effective controls in those industries, especially construction (Tr. 15761–71). For example, Nancy Clark, co-director of Mt. Sinai CHEP, said:

> Practical interventions are available for many identified risk factors. Many workers devise quick fix, homemade solutions to reduce the impact of musculoskeletal stress and promote self-preservation. They use team lifting, mechanized material handlers when available, floor padding for kneeling and standing on, stacking supplies to bring the work closer, and alternating work tasks or body position (Ex. 31–183)

Scott Schneider, director of occupational safety and health for the Laborers Health and Safety Fund of North America, testified:

> [T]here have been many tool manufacturers who have jumped on the ergonomic bandwagon and hired ergonomists to develop better and safer tool designs, from ergonomic hammers with more comfortable shock-absorbing handles to pliers with soil handles and spring returns to reduce the stress of opening them after each use. The use of portable power tools has increased dramatically in construction as batteries have gotten lighter and more powerful. Cordless screw guns have become commonplace in construction over the past few years, reducing the repetitive use of screwdrivers by hand and the force that had to be used. There are simple pieces of equipment, like drywall carrying handles, which I have here, and a mortar-pan stand to raise the height of the pan, which cost less than $50 and can make the work much easier. A D-handle attachment for a shovel, which I have here, costs less than $20, and has been shown to reduce awkward postures during shoveling. There are simple carts for moving glass or drywall, vibration-dampened jackhammers and equipment for moving them on and off of trucks. (Tr. 15762–63).

These commenters also pointed out that many of the controls used in general industry, such as manual handling aids, were applicable or readily adaptable to construction, agriculture and maritime industries (Ex. 31–183). Moreover, tool and equipment interventions are becoming more widely available ''as manufacturers are responding to the need for better ergonomically designed tools'' (Ex. 3–183; see also Tr. 15761–62, 17561).

Finally, several participants were concerned that OSHA's stated intent to promulgate an ergonomics standard for the excluded industries in the future would never come to fruition:

> OSHA's standard-setting history during the past 30 years raises serious doubt that workers excluded from this standard will ever have legal protection from MSD hazards. When OSHA has excluded workers from coverage under a promulgated standard, only in two cases has the Agency followed up to extend coverage to those workers—Hazard Communication and Construction. But those actions were as the result of a court decisions and order (hazard communication) * * * or legislative mandate by Congress (lead) (Ex. 500–218, p. 132–33).

These participants said that if OSHA does not cover construction, agriculture and maritime in the current rulemaking, the Agency should begin further rulemaking immediately and even establish a deadline for completing that project (Exs. 30–400, 30–576, 30–4837, 31–12, 31–263).

OSHA is aware that there is significant evidence in the record indicating that work-related MSDs exist in operations and employment beyond general industry (Exs. 31–183, 500–218, Tr. 7475, 7484–85, 17538–39). Indeed, the problem appears to exist in virtually every industry. Nonetheless, for several reasons OSHA believes its decisions to regulate MSD hazards through sequential rulemaking proceedings, and to limit the first proceeding to general industry, is appropriate and supported by the record.

A primary basis for the Agency's decision to limit the scope of this rulemaking to general industry is that most of the available evidence and data relating to ergonomic interventions addresses general industry. For example, the vast majority of the studies reviewed in both the NIOSH and NAS reports pertained to general industry (Exs. 26–1, 26–37). Similarly, the majority of case studies on the effectiveness of ergonomics programs and control interventions that OSHA had gathered focused on general industry (64 FR 65954–75). Although some participants submitted evidence on ergonomics programs and controls in the excluded industries, mostly in construction (Exs. 32–339–1–25, 32–3888, 38–65, 38–66, 500–210), most of the available evidence continues to pertain to general industry jobs, operations and workplaces.

If it included construction, agriculture and maritime within the scope of this rule, OSHA would have had to delay issuing the rule for general industry while it gathered and analyzed the necessary evidence. Because it is likely that the rule would have a significant impact on small employers in construction, agriculture and maritime, OSHA would also have had to convene a small business review panel pursuant to SBREFA. Further, in order to include construction, agriculture, and maritime in its final rule, OSHA, in the interest of fair notice, would have had to amend the ergonomics proposal or re-propose to include these industries and hold additional hearings. Expanding the rule to cover agriculture, construction and maritime would seriously delay addressing the urgent need for protection for general industry employees, who work in the jobs in which more than 90 percent of MSDs are reported.

In addition, as the proposal pointed out, work conditions and factors present in agricultural, construction and maritime employment often differ from those in general industry. OSHA listed a number of aspects of construction work to illustrate this statement (64 FR 65787):

- They consist primarily of jobs of short duration,
- Employees work under a variety of adverse environmental and workplace conditions (*e.g.,* cold, heat, confined spaces, heights),
- At non-fixed workstations or non-fixed work sites,
- On multi-employer work sites,
- They involve the use of ''day laborers'' and other short-term ''temporary workers,'
- Involve situations in which employees provide their own tools and equipment, and
- Involve employees who may be trained by unions or other outside certifying organizations, rather than by the employer.

OSHA did not mean to imply that the mere existence of any of these factors, alone or in combination, would be enough to justify excluding an entire industry from the rule. This fact was apparently not clear to some commenters, however, who argued that the presence of some of the listed factors in their industries meant that they too should be excluded from the standard (Exs. 30–297, 30–626, 31–147, 32–234, 32–300). For example, Broccolo Tree and Lawn Care Inc., pointed out that landscaping jobs involve short-duration tasks and no fixed workstations (Ex. 31–147). The National Solid Waste Management Association (NSWMA) said that its employees are also exposed to adverse environmental conditions and work at non-fixed work sites (Ex. 32–234, p. 6–7).

In the proposal, OSHA discussed its discretion to set appropriate rulemaking priorities, and to promulgate standards applicable to less than all of American industry. 64 FR 65786–65788. General industry accounts for more than 90 percent of the more than 620,000 LWD MSDs reported each year. By promulgating a standard addressing general industry first, OSHA is giving ''due regard to the urgency of the need'' for a standard to protect general industry employees. 29 U.S.C. 655(b)(7). OSHA has thus ensured that the greatest number of MSD hazards will be addressed by this final rule, while the Agency determines appropriate regulatory approaches for other industries. For example, OSHA has been working closely with NIOSH on a study of ergonomic hazards and solutions in the maritime industry. In addition, OSHA recently published an ergonomics best practices guide for the construction industry on its Web page. OSHA has also provided training grant money targeted to ergonomic hazards in the construction industry.

OSHA intends to develop ergonomics rules that can be tailored to the conditions that are unique to the firms in these industries. OSHA agrees with commenters who have said that the experience the Agency gains from this first phase will provide valuable assistance in developing an effective ergonomics rule for the construction, agriculture, and maritime industries (see, *e.g.,* Ex. 31–252).

As noted earlier, OSHA has decided that the final standard should not cover work performed by persons employed incidentally to or in support of construction, agriculture and maritime operations, regardless of what type of activity they perform. To illustrate, the standard does not cover employees of a residential home building company performing office work in support of construction activities, even though office work is a general industry operation under other OSHA standards. Similarly, the final rule does not cover janitorial workers employed by a shipyard or employees performing regular maintenance on power industrial trucks in a marine terminal. Applying the rule to general industry jobs of a construction employer (the office manager of a construction company, for example) would present the employer with logistical difficulties. Requiring construction, agriculture and maritime employers to set up an ergonomics program for the few general industry employees performing ancillary functions in their workplaces would not be an efficient allocation of safety and health resources. Several commenters have told OSHA that it is most efficient to set up an ergonomics program on a company-wide basis (see, *e.g.,* Exs. 26–1370). Doing so allows employers to implement program elements such as providing employee information and training more efficiently.

B. Railroad Work

Paragraph (b)(3) states that this standard does not cover railroad work. Although some railroad operations are normally covered by OSHA general industry standards, other railroad work is regulated by the Federal Railway Administration (FRA) and not by OSHA. 29 U.S.C. 653(b)(4). In addition, the Preliminary Economic Analysis indicated that the standard would not cover any railroad employment, and this statement caused some uncertainty among affected parties as to the Agency's intent (Ex. 28–1, chapter II, p.3).

In a May 23, 2000 **Federal Register** notice (65 FR 33263), OSHA provided an analysis of the economic impacts of the proposed rule on railroads. On July 7, 2000, OSHA also held a supplemental hearing on this economic analysis, in which the Association of American Railroads (AAR) participated. AAR's comments and testimony, however, highlighted the complexity of the OSHA/FRA jurisdictional issues (Ex. 703–3, Tr. 18272, 18313–16, 18321). OSHA has determined that it needs to gather additional information and conduct further analysis on these issues before it can decide whether and how to address ergonomic hazards in the railroad industry. Therefore, OSHA has decided not to cover any aspect of railroad work at this time.

C. Other Exemptions Requested.

A number of other rulemaking participants also requested that certain jobs, industries or employers be excluded from this rule (*e.g.,* ambulances, landscaping, transfer and storage, petroleum and chemical industries, forging industry). Many requesting exemptions did not provide any reasons why they should be excluded (see, *e.g.,* Exs. 30–303, 30–491, 30–2102, 30–3005, 30–4439, 30–4444, 30–4598, 601–X–1163, 601–X–1438). Some merely said they had ''many work conditions and factors present in the industries OSHA has chosen to exempt,'' but did not discuss either what those factors were or why they supported an exclusion (see, *e.g.,* Exs. 30–2348, 30–3005, 30–3186, 30–3311 30–3462, 30–3482, 30–3582, 33–1181). OSHA does not find any basis for excluding those industries from this rule.

A few requests that included more discussion supporting an exemption are discussed individually:

1. Solid Waste Management

The National Solid Waste Management Association (NSWMA) urged OSHA to exempt the trash collection industry from the standard (Ex. 32–234). NSWMA said an exemption was warranted because, like the construction industry, its working conditions include non-fixed worksites, limited supervisory oversight, adverse environmental conditions, and high employee turnover. In addition, according to NSWMA, ''uncontrollable'' factors, such as variable load weights, municipal regulations, and its members' lack of control over the location of the garbage they collect, also support an exemption. Finally, NSWMA also argued that there is little available information about health effects and effective solutions in the industry. The West Coast Refuse and Recycling Coalition and the Municipal Waste Management Association (MWMA), representing municipal solid waste agencies in larger cities, requested an exemption for some of the same reasons (Ex. OR 323, Tr. 17972–73). Although OSHA recognizes that employers in this industry face particular challenges in implementing some types of ergonomic controls, it does not believe that the arguments presented compel exemption of the solid waste and recycling industry from this standard.[1]

As noted above, OSHA does not believe that the fact that some aspects of an industry's working conditions are similar to some of the conditions in exempted industries necessarily warrants exempting those industries. In any event, the working conditions in the solid waste industry differ significantly from those in construction. In the solid waste industry employees repeat the same routes every week or more frequently. The route is a fixed worksite that the employee gets to know. Because the route is fixed, the employer is able to anticipate and plan for the hazards that the employees might encounter. Likewise, the fixed routes enable employers to plan for how the changing seasons will affect collection on the route. NSWMA's testimony that a ''vast majority * * * if not all'' of its member

[1] A number of participants who argued that compliance with an ergonomics standard would be infeasible in their industries also submitted examples of industry ''best practice'' guidelines and similar recommendations to the record. The participants said that even these ''best practices'' do not result in enough of a reduction in employee exposure to MSD hazards that further MSDs are ''unlikely.'' OSHA recognizes that some industries will not be able to control exposures completely. OSHA also, however, approves of the steps these industries are taking to control MSD hazards to the extent they can, and commits to working with the industries in the future. This type of arrangement will help provide employees in these industries with as much protection as possible, while reassuring their employers that OSHA understands the limits of their capabilities.

companies have safety and health programs that include addressing ergonomic hazards on a ''day to day'' basis indicates that most industry employers already are taking these steps (Tr. 18074).

Although NSWMA argued that high turnover in the industry supports exemption in the same way that the use of ''day laborers'' in the construction industry does, NSWMA did not provide any evidence on turnover rates in its industry, or on how those rates compare to other industries this rule covers. Nor did NSWMA explain why high turnover rates pose the same issues as day laborers. Other solid waste associations and employers did not indicate that high turnover rates are a problem in the industry. The solid waste industry has the opportunity to train its workers; in fact NSWMA and MWMA testified that their members already provide training (Tr. 13404–405, 18079). It explained that this training is the most effective way to deal with the fact that its workers are often unsupervised:

> MR. BEDERMAN: No, the most important way to monitor this type of thing is actually not to monitor it, but * * * actually good training (Tr. 18079).

The record also does not support industry claims that solid waste industry employers have little control over their employees' working conditions. For example, NSWMA said that, because of municipal ordinances, its members have no control over the weight and location of the garbage they collect and that municipalities were ''very hesitant'' to make changes (Ex. 32–234–2, Tr. 18041). But 60 percent of residential collection is privately controlled (Tr. 18046). For the 40 percent of trash collection that is under the control of municipalities, as noted below, the testimony of NSWMA and MWMA suggest there is not a significant problem.

NSWMA testified that a majority of municipalities have already implemented container requirements (Tr. 18071; see also Tr. 13402). Both NSWMA and MWMA testified that the growing trend is toward requiring customers to place garbage containers at the curbside (to eliminate the need for employees to carry heavy containers) and limiting container size (to reduce injury associated with heavy lifting) (Tr. 18070–71, 13402–3; see also Tr. 12019). Bruce Walker, of Portland's solid waste and recycling agency, said that such weight limits had been positively received in that city (Tr. 12014–15). NSWMA, MWMA and Mr. Walker also said that employers are instructing their employees not to lift containers that exceed the weight limits (Tr. 12014, 13404–06, 18073). In addition, container size and location issues are regularly addressed as part of contract negotiations between private collectors and municipalities (Tr. 18041). All of this evidence suggests that solid waste employers should not have difficulties continuing to negotiate contracts that will assist them in complying with this final standard.

And contrary to NSWMA's argument, the record contains abundant evidence on MSD hazards and ergonomic solutions in this industry (Ex. 32–234–2). The industry recognizes that lifting heavy loads creates a hazard for employees (Tr. 13406, 13413, 18009). Industry representatives testified that their workers experience work-related MSDs, particularly MSDs of the lower back (Tr. 13379, 13396, 13412, 18009). In fact, NSWMA submitted a manual of recommended ergonomic practices developed by Environmental Industry Associations (EIA), NSWMA's parent organization, that identified lifting bulky loads and twisting and carrying loads as risk factors for the industry and identified back pain, hernias and strains, sprains and tears as common MSDs in the industry (Ex. 32–234–2–1). EIA also recommended that employers establish ergonomics programs for trash collection and recycle operations (Ex. 32–234–2–1).

The record also includes evidence on a wide range of controls that are successfully in use in the industry. The EIA manual on ergonomic practices said the industry ''has many options'' for addressing ergonomic hazards, including weight limits built into residential contracts, the use of lifting devices, and training (Ex. 32–234–2–1). The record indicates that the following controls are also in use in the industry:

- Mechanical container lifts,
- Limits on container size and weight and requirements for container handles,
- Carts, dollies and other mechanical assists for pushing, carrying and lifting containers,
- Collection trucks designed for use in narrow alleys and streets to eliminate carrying containers long distances,
- Changes in municipal collection regulations to reduce lifting hazards (*e.g.,* curbside service, container size and weight limits, reduction in loads through increases in collections per week, separate collections for large bulky items),
- Training in proper lifting techniques,
- Work practice controls (*e.g.,* training not to lift overweight loads),
- Changes in compensation systems to eliminate incentives for hazardous work speed and lifting (Tr. 12017, 13402–06, 17969, 18212).

John Legler, of Waste Equipment Technology Association, added that garbage trucks are being retrofitted with mechanical lifts ''quite regularly'' (Tr. 18012–13). Bruce Walker, of Portland's residential solid waste and recycling agency, testified that enforcing container weight limits had been established had led to low MSD rates (Tr. 11968–70).

This evidence not only does not support exemption, it is clear evidence that effective ergonomic programs and controls are technologically and economically feasible for the industry as a whole. OSHA recognizes that some of the hazards facing waste industry employees cannot be eliminated completely. But the standard only requires employers to control MSD hazards ''to the extent feasible.'' It expects NSWMA's member companies to continue to implement the type of safety programs they are already using, and to continue improving those programs as knowledge and technology advance.

2. Utility Workers

Utility companies asked OSHA to exempt utility line workers and power plant maintenance workers from the standard for two reasons. First, they pointed out that line workers face some of the same conditions as construction, agriculture and maritime (*e.g.,* adverse environmental conditions). They also argued that these jobs involve both general industry and construction activities because utility line workers not only maintain and repair utility lines, a general industry activity, but also they install, alter, and improve lines, activities which are governed by OSHA construction standards (Exs. 30–3853, 32–300, Tr. 2893–95). Edison Electric Institute (EEI) testified:

> As you know, a line worker working on a pole may at one moment be engaged in what is considered to be construction work under 1910.12(b) and under 1926(b) and at the next moment be engaged in what is considered to be general industry work under 1910.269. That is to say that if a person is doing work for the improvement of the facility, that is construction as defined by OSHA and the Review Commission. And if not, then general maintenance (Tr. 97–98).

EEI also pointed out that it would not be practical for its employees to be covered by the standard for only some of their tasks:

> EEI recommends that OSHA clarify that to perform a job hazard analysis means to analyze a job, not a task. A job may not involve only one task, but may involve multiple tasks depending upon the nature of

the work on that given day (Ex. 32–300, p. 29).

OSHA agrees with EEI that determining whether a job exposes an employee to an MSD hazard requires looking at all of the tasks and activities that comprise that job. That is what this job-based standard requires. But as EEI itself pointed out, some utility companies already have programs in place for analyzing and controlling MSD hazards (Ex. 30–2725, Tr. 2384, 2396–98). Presumably, these companies analyzed the entire jobs of utility line workers and power plant maintenance personnel rather than just the general industry tasks in those jobs. None of the utility companies indicated that construction activities constitute the primary operations of utility companies. Thus, including all rather than part of the tasks of these jobs in the ergonomics program this rule requires should not impose a substantial additional burden for utility companies. OSHA requires utility companies to protect their employees, including those that spend part of their days performing construction work.

3. Building Materials Distributors

A number of building materials distributors argued that they should be exempted because a large portion of their business involves delivering supplies to construction sites and to various places on construction sites (Exs. 30–541, 30–4267, 30–4351). Because of this, they said, their employees are exposed to the same ergonomic risk factors and adverse working conditions that justified an exclusion for the construction industry. OSHA has never excluded general industry employers from standards because they provide equipment or materials for exempted industries. Thus, while marine terminals are excluded from this standard, manufacturers and transportation companies that deliver new equipment to marine terminals are still covered.

In addition, almost every comment received from building materials distributors indicated that the industry has already taken substantial steps to control MSD hazards. For example, Panther Building Materials, Inc., said that it provides hydraulics crane, carts and other material handling equipment in order to safely deliver supplies (Ex. 30–4351). It also provide at least two employees per truck crew in order to minimize carrying.

4. Home Health Care.

The American Association for Homecare (AAHomecare), asked that the home health care industry be exempted from the standard because home health care employees perform work in private homes that are not under the employer's control.

AAHomecare said its industry should be exempted because OSHA has indicated that it will not impose OSHA standards on private homes, unless they are being used as part of the ''manufacturing process'' (Ex. 30–3862). But the OSHA policy AAHomecare refers to only addresses work that employees perform in their own homes.

AAHomecare also argues that the court in the Bloodborne Pathogens decision (*American Dental Association.* v. *Martin*, 994 F.2d 823 (7th Cir. 1993)), held that the OSH Act ''does not authorize OSHA to impose work-site related standards on home work sites that are not under the employers control'' and that the Agency's directive limiting the application of the Bloodborne Pathogens rule at home-based worksites (CPL 2–2.44D) should apply to this standard as well (Ex. 30–3862). But the Seventh Circuit did not make as broad a holding as AAHomecare suggests. The court said only that OSHA has an ''obligation to consider such questions and the general issue that they present before imposing'' a standard. American Dental Assn., 984 F.2d at 830.

In this case, OSHA is considering these issues and addressing them here. In general, employers sending their employees to work at sites they do not control are required to do everything within their control to protect those employees, but will not be held liable for the existence of conditions they cannot control. Thus home health care agencies must provide their employees with the information required by paragraph (d), provide those employees with MSD management where an MSD incident occurs in a job that meets the levels in the Basic Screening Tool, and perform job hazard analyses when necessary. In addition, they must comply with the other programmatic elements of the standard, in particular providing the employees with necessary training and equipment to minimize ergonomic hazards.

But employers' control obligations will be limited by the control they have over their employees' actual working conditions. Thus an employee who is expected to move patients in their own homes should be taught how to do so as safely as possible. For example, evidence was submitted to the record that portable lifting devices and other control measures are available for use in home settings (Ex. 37–4, Tr. 11743–45). According to witnesses, some portable lifting devices have been designed especially for home settings (Tr. 11743–45). The witnesses said that these devices allow mechanical transfer in and out of bed, onto a toilet, and even into a tub (Tr. 11745). Other control measures described in the record include friction reduction sheets, gait belts, toilet and shower chairs, slide boards, and convertible chairs and wheelchairs (Ex. 37–4). To the extent these controls are feasible, and employers find them to be effective, employers could provide them to their home health worker employees. But an employer is not expected to change the configuration of a patient's bedroom or bathroom, although it must provide the worker with the training and controls necessary to allow him or her work as safely as possible in that location.

5. Small Businesses

A number of commenters said OSHA should exempt small businesses because compliance would be too burdensome (Ex. 30–3167, Tr. 3126–27, 3332). They said that small businesses do not have the knowledge or resources to hire outside experts to help identify and address MSD hazards (Tr. 3127). They also said that MSD rates were low for small businesses (Exs. 30–3167, 600–X–1, Tr. 3332). National Small Business United (NSBU) said that for the majority of small businesses the occurrence of an MSD was rare (Ex. 30–3167). By contrast, another participant (Ex. 26–1370) at OSHA's stakeholder meetings for Ergonomics Program Standard Development specifically supported the inclusion of small employers in the rule, saying that the rule was particularly needed in these facilities because they were less likely already to have either an ergonomics or a safety and health program (Exs. 26–1370).

OSHA considered whether to apply alternative regulatory provisions to small employers as part of the analysis required by SBREFA and the Regulatory Flexibility Act (64 FR 66040–53). OSHA does not believe the record supports such an approach for small business. First, employees who work for small businesses are experiencing work-related MSDs, and they need the protection this standard will provide. According to BLS, employees in establishments of all sizes have reported MSDs that are serious enough to involve days away from work.

In a number of industries comprised predominantly of small businesses, the risk of MSDs is particularly high. This is especially true in the health care industry. For example, many medical sonographers are employed by small businesses. Joan Baker, of the Society of Diagnostic Medical Sonographers, testified that the MSD prevalence rate among sonographers exceeds 80 percent and that the frequency and severity of these MSDs appears to be increasing (Tr. 11881–82). Dr. Linda Morse, chief of occupational medicine at Kaiser San Francisco, said that the injury rate among ultrasound technicians in Northern California was almost 100 percent (Tr. 15045). Many nurses, nurses' aides, and orderlies are also employed by small businesses, including small nursing homes and small health care agencies. According to BLS, in 1996 about 15 percent (more than 103,000) of all MSDs resulting in days away from work were reported by health care workers. In addition, the American Nurses Association and the Service Employees International Union, among others, testified that the occurrence of MSDs among home health workers is particularly high (Exs. 32–274–1, 502–215).

OSHA does not believe this standard will be too burdensome for small businesses. The record shows that many small businesses have successfully implemented ergonomics programs (see, *e.g.,* Exs. DC 66, 500–208–3, Tr. 17350–17355). These programs have paid for themselves in terms of reductions in medical costs, lost workdays and product reject rates (Tr. 17354). Moreover, if small businesses have low rates of MSDs, the obligations for those employers will be commensurately small (Ex. 30–3167). The only obligation that many small employers will have is a one-time requirement to provide basic information to their employees. And these employers can satisfy that burden by copying, distributing, and posting the information sheets in Appendices A and B.

The record shows that small businesses are easily able to get the information they need to address MSD hazards. A number of organizations have developed and are providing model programs, checklists, ''best practices'' guides and control information to small businesses (see, *e.g.,* Exs. 32–234–2–1, OR 351). A number of organizations have developed and are providing model programs, checklists, ''best practices'' guides and control information (Exs. 32–234–2–1, OR 351). For example, the American Dental Association and state affiliates, such as the Oregon Dental Association, have developed and disseminated information on ergonomics for its members and held a ''Dental Ergonomics Summit Conference'' this year (Ex. OR 351). A number of trade associations are also providing ergonomics training for small businesses (Ex. 37–25, OR 351). For example, Suzanne Rodgers, an ergonomist with 32 years of experience assisting a wide range of companies in addressing MSD hazards, said that she has provided training to small businesses at various conferences organized by the Chamber of Commerce (Ex. 37–25).

There are also other sources of information and assistance for small employers. OSHA and NIOSH provide free hazard evaluation services for small employers. OSHA will be providing additional information in the appendices to this final rule and other materials on the OSHA Webpage (*www.osha.gov*). Many other Internet sites also provide free ergonomics information.

III. Other Scope and Application Issues

A. Jobs Involving Both General Industry and Non-General Industry Tasks

Several commenters raised questions about whether this standard applies when an employee's job involves both general industry and non-general industry activities (Exs. 30–3853, 32–300, Tr. 2893–95). As explained above in reference to utility workers, because this is a job-based standard, OSHA intends employers to include all employees who perform general industry work within this standard, even if those employees also perform some work that may be classified as construction, agriculture, or maritime. Thus, employers engaged in landscaping or lawn and garden services, a general industry classification, are covered by this standard even if their employees' jobs include some harvesting of sod or trees, an agricultural classification. On the other hand, nurseries and tree farms, which are agricultural classifications, need not comply with the standard even if their employees perform some minor landscaping or horticultural services. Comments by the AFL–CIO best sum up the need for defining the application of the standard in this way:

> Since this is a job-based standard, it is important that jobs in fact are covered. To apply the standard in some aspects of a job and not others would leave workers without protection and make compliance and enforcement confusing and difficult (Ex. 500–218, p. 133).

In addition, as stated in the discussion of utility line workers, the only way an employer can determine whether a job exposes an employee to an MSD hazard is to look at all the tasks and activities that comprise that job. Eliminating some tasks from this analysis may prevent identification of risk factors that are causing or contributing to the hazard. If employers do not have that information, the controls they implement may not be successful. Therefore, in order to ensure that an employee is protected from MSD hazards while performing the general industry tasks, it may be necessary to control risk factors for the job as a whole.

B. Multiple Employer Worksites and Contract or Shared Employee Situations

A number of participants asked how the standard would apply at multi-employer worksites. Similar situations arise under many standards, and OSHA has published a ''Multi-Employer Citation Policy'' that discusses the allocation of responsibility among various categories of employers. CPL–0.124 (Eff. Dec, 10, 1999). OSHA has not historically discussed the operation of this policy in rulemaking documents, viewing it as an enforcement issue. In a challenge to OSHA's Bloodborne Pathogens standard, however, the United States Court of Appeals for the Seventh Circuit held that, where parties to a rulemaking raise issues about the application of the standard in this circumstance, OSHA should discuss the application of this policy. *American Dental Ass'n.* v. *Martin,* 984 F.2d 823 (7th Cir. 1993). Such a discussion is particularly useful with respect to some of the issues raised by this standard.

Under the multi-employer worksite policy, employers are generally required to take whatever steps are within their power to protect their own employees, and also to abate hazards within their control when other employees are exposed to those hazards. This means that an employer whose employees are working at a location controlled by another employer, for example a temporary services agency, must provide its employees with the information required by paragraph (d). Both employers will need to know if an employee reports an MSD, and must implement measures to share this information. They should consult to determine whether the report qualifies as an MSD incident under this standard, but the employer with control over the workplace must screen the job to determine whether further action is required. If so, the employer with control over the workplace must also implement the program elements required by this standard. And if such an employer hires a temporary worker to work in a job for which an ergonomics program under this standard is already in place, that employer must provide the temporary employee with any necessary training. The employing agency, however, will necessarily be responsible for providing the employee with any necessary MSD management, including WRP. OSHA believes that this is basically how businesses are currently operating. OSHA expects that they may pay more attention to these issues and address them explicitly in their contracts after the standard is in effect.

C. United States Postal Service

Questions were also raised as to the effect of this standard on the United States Postal Service. In 1998, Congress amended Section 3(5) of the OSH Act to include the United States Postal Service within the Act's definition of employer. 29 U.S.C. 652(5). Postal Service Enhancement Act, P.L. 105–241. As a result, this standard applies to all USPS operations that are not construction, agriculture or maritime operations.

D. Municipalities

A number of municipalities asked whether the standard applies to local governments. States and their political subdivisions are not employers under the OSH Act, and they are not covered by this final rule or any other federal OSHA standards. However, the 23 States and 2 Territories with approved State Plans are required by Section 18(c)(2) of the OSH Act to issue standards that are ''at least as effective'' as Federal standards. 29 U.S.C. 667. Therefore, State Plan States must adopt ergonomics program standard within six months of the publication of this standard. Under Section 18(c)(6), State Plan States must apply such standards to State employees and to employee's of the State's political subdivisions. (See State Plan States section of this preamble for the list of State plan States.)

Industries and Jobs This Standard Covers

- Agricultural services
- Soil preparation and crop services, including crop planting, cultivating and protecting
- Crop harvesting
- Veterinary services
- Lawn and garden services
- Ornamental shrub and tree service
- Tree trimming
- Landscaping and horticultural services
- Oil and gas drilling/extraction operations
- Health care employees
- Truck driving
- Office workers employed by general industry establishments
- Office workers employed by agricultural services establishments
- Utility line operations including maintenance, repair, installation, construction, alteration and improvement operations
- Power plant maintenance operations including repair, alteration and improvements
- Boat building and repair
- Airline baggage handlers
- Airline reservation and ticket agents
- Airline maintenance crews
- Railroad equipment building and rebuilding
- Maintenance of equipment or structures
- Forestry services
- Forestry nurseries and gathering of forest products
- Commercial fishing
- Fish hatcheries and preserves
- Hunting and trapping
- Game propagation
- State and municipal employees (in State Plan States) performing general industry operations
- U.S. Postal Service
- Federal government employees performing general industry operations

Industries and Jobs This Standard Does Not Cover

- Construction employment and operations
- Agriculture employment and operations
- Farm labor and management services
- Livestock and animal specialty services
- Maritime employment and operations
- Ship building and repair
- Longshoring
- Office workers employed by construction, agriculture or maritime establishments
- Maintenance workers employed by construction, agriculture or maritime establishments
- Work at the employee's own home
- Railroad work
- Railroad terminal and switching
- Airline attendants
- Airline pilots

Paragraph (c)—How Does This Standard Apply if I Already Have an Ergonomics Program in Place When the OSHA Ergonomics Program Standard Becomes Effective?

Paragraph (c) of the final standard is a grandfather clause, which, under certain conditions, permits an employer who has already implemented and evaluated his or her ergonomics program by the date on which the final rule becomes effective to continue that program instead of complying with the OSHA standard. This paragraph permits employers to do this only if the program: is in writing, contains the core elements of basic ergonomics programs, and is demonstrably effective. The criteria for judging whether an employer's program adequately addresses the core elements are contained in paragraphs (c)(1)(i) through (v). Examples of criteria for judging the effectiveness of the program are contained in paragraph (c)(1)(v). Paragraph (c)(2) requires that, within 1 year of the standard's effective date, grandfathered programs have in place an MSD management policy that meets the requirements of paragraphs (p) through (s) of the final rule. Final paragraph (c)(3) denies grandfather status to employers who have policies or procedures that discourage employees from participating in the program or reporting signs or symptoms of MSDs or the presence of MSD hazards in the workplace.

In the final rule, OSHA is requiring that grandfathered programs be in writing. The final rule's grandfather clause requires the employer to demonstrate program effectiveness and, like the proposal, to have a program that includes the core elements of effective programs. The Agency believes that this can best be accomplished with a written program. Further, both OSHA and the employer will find compliance with the grandfather clause easier to demonstrate if the program is written. By ''written,'' OSHA also intends that the program can be maintained electronically.

Final paragraph (c)(1) requires grandfathered programs to include the core elements of effective ergonomics programs: management leadership and employee involvement; job hazard analysis and control; training; and program evaluation. This paragraph also indicates the subelements within each core element that OSHA believes are essential to the proper functioning of that core element. These subelements are stated broadly. For example, a subelement of management leadership (paragraph (c)(1)(i)) that OSHA considers essential is the establishment of an effective reporting system that permits employees to report the signs and symptoms of MSDs and to receive prompt responses to their reports. The employer's program must include all of the subelements of the core elements to qualify for grandfather status.

The following discussion explains the subelements comprising each of the core elements. Employers are free to include additional elements or subelements in their program, and doing so will not interfere with the program's grandfather status, provided that the program includes the core elements identified by paragraphs (c)(1)(i) through (v), and the subelements associated with them.

The proposed rule would have required an existing program to meet a ''basic obligation'' provision for each core element. Basic obligations, which were intended to capture the essence of the more detailed subelements proposed for each core element, were proposed for each program element. Table 1 compares the proposed rule's basic obligations sections with the corresponding subelements of the final rule's grandfather clause. The following discussion also explains OSHA's reasons for revising the basic obligations proposed.

Final paragraph (c)(1)(i) states that grandfathered programs must include management leadership and identifies the subelements for that core element. Employers are required to demonstrate management leadership of their ergonomics program through the following subelements: an effective MSD reporting system and prompt responses to employee reports, the assignment of clear program responsibilities, and regular communication with employees about the ergonomics program. OSHA's experience has shown that, to be effective, management leadership must be active rather than passive. Leadership that is limited to a ''paper program'' with written policies and procedures but is not translated into practice by management would not meet the intent of this provision. On the other hand, management leadership that is known throughout the organization because of management's active engagement in the ergonomics process and appropriate follow-through on commitments would clearly fulfill this intent. The final rule's management leadership subelements are equivalent to those of the proposed basic obligation for this core element, except that OSHA has added ''regular communication with employees'' and ''prompt'' responses to reports to the subelements of the final rule's grandfather clause. The Agency has added these subelements to make sure that management leadership is responsive to employee reports and that management's commitment to the ergonomics program is communicated from top management down to the employees performing the work and implementing the program. Taken as a whole, OSHA believes that the subelements in final paragraph (c)(1)(i) will ensure that grandfathered programs have active rather than passive management leadership.

Final paragraph (c)(1)(ii) requires that grandfathered programs include employee involvement, as demonstrated by the early reporting of MSDs and active employee involvement in the implementation, evaluation, and future development of the employer's ergonomics program. OSHA has vigorously advocated employee participation in workplace safety and health issues for many years and is pleased by the growing recognition of the importance of employee participation on the part of private-sector companies, trade associations, safety and health professionals, and employees themselves. OSHA supports employee participation because employees have the most direct interest in their safety and health on the job, they have an in-depth knowledge of the tasks they conduct at the worksite, they often have excellent ideas on how to solve ergonomic problems, and their interest in the program is vital to its success. If employees do not report their MSD signs and symptoms or MSD hazards, any ergonomics program will fail. OSHA has specifically included in paragraph (c)(1)(ii) a provision that employees be involved in the implementation, evaluation, and future development of grandfathered programs to make it clear that employee involvement extends to every element of the program, including program evaluation and future modifications to the program to reflect changes over time.

Final paragraph (c)(1)(iii) requires grandfathered programs to contain job hazard analysis and control, as demonstrated by a process for identifying, analyzing, prioritizing (if necessary), and controlling MSD hazards in affected jobs and following up to ensure control effectiveness. This is the heart of any ergonomics program. For employees to be protected from MSD hazards, it is obvious that those hazards must be eliminated or controlled. A note following this paragraph explains that personal protective equipment (PPE) may be used as a supplement to engineering, work practice, and administrative controls. The employer may only use PPE alone where other controls are not feasible. In addition, the note explains that, if PPE is used, the employer must provide it at no cost to employees.

As can readily be seen from Table 1, this provision has been changed substantially from the corresponding requirement in the proposal. The job hazard analysis and control subelements in the final rule's grandfather clause are designed to be less prescriptive and more flexible than those proposed and to fit better with the way rulemaking participants (see, *e.g.,* Ex. 32–77, Tr. 14723, Tr. 4973) described this process in their existing ergonomics programs.

The final rule's grandfather clause requires employers to use a process for identifying, analyzing, and controlling MSD hazards in problem jobs. Employers may also prioritize jobs identified as having MSD hazards and then follow their prioritization scheme when controlling these hazards. Employers with grandfathered programs must also follow up on their hazard control measures to ensure that the controls implemented are effective. This is the process that participants in the rulemaking told OSHA they use in their existing ergonomics programs. Companies like the Dow Chemical Company (Ex. 32–77; Tr. 5297), Levi Strauss (Tr. 14723, 14736, 14746), the Consolidated Edison Company of New York (Tr. 4644), and IBP, Inc. (Tr. 4973) described a process that includes these job hazard analysis features.

As discussed in the summary and explanation for the standard's job hazard analysis and control requirements (paragraphs (j) through (m)) later in this section of the preamble, the rulemaking record demonstrates that, currently, employers with existing programs do not always fix all problem jobs, nor do they eliminate all MSDs. To address these facts, the final rule's grandfather clause (1) permits employers to bring all problem jobs into their programs, and (2) acknowledges that employers will not eliminate all MSDs. Employers with grandfathered programs must, however, implement controls that (1) control the MSD hazards, (2) reduce MSD hazards to the levels specified in Appendix D, or (3) reduce MSD hazards to the extent feasible. These are the same compliance endpoints specified in paragraph (k)(1) of the final rule. These endpoints are explained in the summary and explanation for that paragraph.

Thus, the grandfather clause in the final rule will enable employers with existing programs that only address certain jobs to qualify for the grandfather clause if they include all problem jobs in their program before the standard's effective date. Thus, even programs that do not currently address all problem jobs would not be precluded from qualifying for grandfather status, providing that they revise their approach to include all such jobs before the standard is in effect.

Final rule paragraph (c)(1)(iv) requires grandfathered programs to provide for the training of managers, supervisors, and employees in the employer's ergonomics program and their role in it; the recognition of MSD signs and symptoms; the importance of early reporting; the identification of MSD hazards, and methods that the employer is using to abate them. Training is to be provided at no cost to the employees trained. Training is necessary to ensure that employees in problem jobs, their supervisors, and the individuals who set up and manage the ergonomics program are provided with the knowledge and skills necessary to recognize MSD signs, symptoms, and hazards in their workplace and to effectively participate in the ergonomics program. These individuals also need to be trained in the need for early reporting. The length and frequency of training is determined by the needs of the workplace. Periodic training is necessary to address new developments in the workplace and to reinforce and retain the knowledge already acquired in previous training, but to make this element as flexible as possible, OSHA is not specifying the frequency with which training must be provided.

Final rule paragraph (c)(1)(v) requires grandfathered programs to include evaluations of the program, as demonstrated by regular reviews of the elements of the program, the effectiveness of the program as a whole, and the correction of identified deficiencies. This means that employers must, at a minimum, assess the functioning of their ergonomics program, compare its provisions to the elements and subelements specified in the grandfather clause, identify any deficiencies in the program, and correct them. Employers are required to make sure that the ergonomics program they have implemented is eliminating or controlling the MSD hazards in jobs in their workplace. A program designed for a large site with many different jobs, for example, is likely to be more formal and extensive than one designed for a small site with one or two high-risk jobs. Similarly, an ergonomics program that fits a manufacturing facility may not be appropriate for a work environment in the service sector. To make the evaluation requirements for grandfathered programs as flexible as possible, OSHA is not specifying the frequency with which evaluations must be conducted. However, employers do need to reevaluate their programs periodically to ensure that they are performing up to expectations.

Final rule paragraph (c)(1)(v) also requires the program evaluation to review the effectiveness of the program, using such measures as: reductions in the number or severity of MSDs, increases in the number of jobs in which ergonomic hazards have been controlled, reductions in the number of jobs posing MSD hazards to employees, or any other measure that demonstrates program effectiveness.

Lastly, final rule paragraph (c)(1)(v) requires the employer to conduct at least one review of the elements and effectiveness of the program before January 16, 2001. This provision, which is discussed in detail below, ensures that only effective programs are grandfathered. Although paragraph (c)(1)(v) requires employers to correct deficiencies in the program, OSHA would not consider an employer who uncovers major deficiencies in the program elements or whose evaluation does not demonstrate the overall effectiveness of the program to be in compliance with this paragraph. Requiring any program that is grandfathered to be demonstrably effective is basic to employee protection and to ensuring that grandfathered programs are at least as effective as the programs required by the standard OSHA is promulgating for all general industry employers and employees.

The final rule's grandfather clause does not identify specific rates of MSDs or other similar measures of effectiveness that a grandfathered program must achieve because OSHA is aware that the programs grandfathered in will be at many different stages of program development and because OSHA wishes to recognize as wide a range of existing effective programs as possible. Although the grandfather clause does not set a specific reduction goal, employers are required by paragraph (c)(1)(v) to demonstrate the effectiveness of their programs.

Paragraph (c)(2) of the final rule requires employers with grandfathered programs to institute an MSD management policy (including work restriction protection) that meets paragraphs (p) through (s) of the final rule within 12 months of the effective date of the standard. Thus, the final rule's grandfather clause is designed to recognize existing ergonomics programs that are effective even if they do not have an MSD management policy until a year after the effective date of the standard.

OSHA believes that all successful ergonomics programs depend on the early reporting of and intervention with regard to MSD signs and symptoms; this is as true for grandfathered programs as for those that are not grandfathered. As discussed at length in connection with paragraph (r), OSHA has found, both on this record and in the records of many other OSHA standards, that wage and benefit protection is essential to early reporting and employee participation in the employer's program. Without such protection, employees fear economic loss and often simply do not report their signs and symptoms until the injury has progressed to the point where work (and perhaps full recovery) is no longer possible. In addition, as fully explained in the summary and explanation for paragraphs (p) through (s) of the final rule, when an employee reports an MSD, early intervention is required to ensure appropriate treatment, work restrictions, and follow up. OSHA anticipates that many existing programs will be able to meet the requirements of paragraph (s) by use of the dispute resolution mechanisms described in paragraph (s)(5).

Final rule paragraph (c)(3) states that an ergonomics program of an employer who has policies or procedures that discourage employee from participating in the program or reporting the signs or symptoms of MSDs or the presence of MSD hazards in the workplace does not qualify for grandfather status. This provision, which is equivalent to paragraph (h)(3) of the final rule, ensures that employees are as free to participate fully in grandfathered programs as employees in programs that are not grandfathered. As discussed at length in connection with paragraph (h)(3), OSHA has found that employee participation is essential to a program's effectiveness and that a prohibition on policies that inhibit that participation is warranted.

TABLE 1—COMPARISON OF PROPOSED BASIC OBLIGATIONS WITH FINAL GRANDFATHER CLAUSE PROGRAM ELEMENT CORE ELEMENTS AND SUBELEMENTS

Proposed basic obligation	Corresponding core elements and subelements of the final grandfather clause
Proposed Management Leadership Obligation	Final § 1910.900(c)(1)(i) and (ii) and (c)(3): [Your program must contain the following elements:]
You must demonstrate management leadership of your ergonomics program. Employees (and their designated representatives) must have ways to report MSD signs and MSD symptoms; get responses to reports; and be involved in developing, implementing and evaluating each element of your program. You must not have policies or practices that discourage employees from participating in the program or from reporting MSD signs or symptoms.	(c)(1)(i) Management leadership, as demonstrated by an effective MSD reporting system and prompt responses to reports, clear program responsibilities, and regular communication with employees about the program; (c)(3) An employer who has policies or procedures that discourage employees from participating in the program or reporting the signs or symptoms of MSDs or the presence of MSD hazards in the workplace does not qualify under paragraph (c) of this section.

TABLE 1—COMPARISON OF PROPOSED BASIC OBLIGATIONS WITH FINAL GRANDFATHER CLAUSE PROGRAM ELEMENT CORE ELEMENTS AND SUBELEMENTS—Continued

Proposed basic obligation	Corresponding core elements and subelements of the final grandfather clause
Proposed Employee Participation Obligation:	
You must set up a way for employees to report MSD signs and symptoms and to get prompt responses. You must evaluate employee reports of MSD signs and symptoms to determine whether a covered MSD has occurred. You must periodically provide information to employees that explains how to identify and report MSD signs and symptoms.	(c)(1)(ii) Employee participation, as demonstrated by the early reporting of MSDs and active involvement by employees and their representatives in the implementation, evaluation, and future development of your program; [See also paragraph (c)(1)(iv).]
Proposed Job Hazard Analysis and Control Obligation:	Final § 1910.900(c)(1)(iii): [Your program must contain the following elements:]
You must analyze the problem job to identify the ergonomic risk factors that result in MSD hazards. You must eliminate the MSD hazards, reduce them to the extent feasible, or materially reduce them using the incremental abatement process in this standard. If you show that the MSD hazards only pose a risk to the employee with the covered MSD, you may limit the job hazard analysis and control to that individual employee's job.	Job hazard analysis and control, as demonstrated by a process that identifies, analyzes, and uses feasible engineering and administrative controls to control MSD hazards or to reduce MSD hazards to the levels specified in Appendix D or to the extent feasible, and evaluates controls to assure that they are effective. **Note to Paragraph (c)(1)(iii):** Personal protective equipment (PPE) may be used to supplement engineering and administrative controls, but you may only use PPE alone where other controls are not feasible. Where PPE is used you must provide it at no cost to employees.
Proposed Training Obligation:	Final § 1910.900(c)(1)(iv): [Your program must contain the following elements:]
You must provide training to employees so they know about MSD hazards and your ergonomics program and measures for eliminating or materially reducing the hazards. You must provide training initially, periodically, and at least every 3 years at no cost to employees.	Training of managers, supervisors, and employees (at no cost to these employees) in your ergonomics program and their role in it; the recognition of MSD signs and symptoms; the importance of early reporting; the identification of MSD hazards in jobs in your workplace; and the methods you are taking to control them.
Proposed MSD Management Obligation:	Final § 1910.900(c)(2): [Your program must contain the following elements:]
You must make MSD management available promptly whenever a covered MSD occurs. You must provide MSD management at no cost to employees. You must provide employees with the temporary ''work restrictions'' and ''work restriction protection (WRP)'' this standard requires.	By January 16, 2002, you must have implemented a policy that provides MSD management as specified in paragraphs (p), (q), (r) and (s) of this section.
Proposed Program Evaluation Obligation:	Final § 1910.900(c)(1)(v): [Your program must contain the following elements:]
You must evaluate your ergonomics program periodically, and at least every 3 years, to ensure that it is in compliance with this standard.	Program evaluation, as demonstrated by regular reviews of the elements of the program; regular reviews of the effectiveness of the program as a whole, using such measures as reductions in the number and severity of MSDs, increases in the number of jobs in which ergonomic hazards have been controlled, or reductions in the number of jobs posing MSD hazards to employees; and the correction of identified deficiencies in the program. At least one review of the elements and effectiveness of the program must have taken place prior to [insert date 60 days after the publication date of this standard].

The following paragraphs discuss the comments, evidence and testimony received on the proposed grandfather clause and present OSHA's reasons for accepting or rejecting the rulemaking participants' suggestions and for including the final rule's grandfather clause requirements.

1. Whether the Proposed Standard Would Recognize Existing Effective Programs

Many rulemaking participants said that the proposed rule's grandfather clause would not, as drafted, recognize existing effective programs (see, *e.g.,* Exs. 30–574, 30–973, 30–1722, 30–3765, 30–3813, 30–3815, 30–3845, 30–3853, 30–3934, 30–3956, 30–4185, 31–297, 32–141; 500–188; Tr. 3320, 4137, 11265, 11290, 11615). Most of these commenters argued that the proposed standard would only permit existing programs that already met all of the details of the program required by OSHA's standard to be grandfathered (see, *e.g.,* Exs. 30–1722, 30–3853, 30–3934, 30–3956, 32–141; Tr. 11265, Tr. 11290, Tr. 11615). According to these commenters, the basic obligation OSHA proposed for each core element would in actuality have required an employer to meet each of the proposed subrequirements under that core element. Thus, they reasoned that the proposed grandfather clause would only recognize existing programs that already met all of the particulars of the program envisioned by OSHA's proposed standard even in cases where the employer's program had been demonstrated to be effective in preventing MSDs. For example, the U.S. Chamber of Commerce stated this view as follows:

> OSHA claims that employers who already have ergonomics programs in place ''may continue that program, even if it differs from the one [the proposed] standard requires'' if the program meets certain requirements * * *. The Proposed Rule requires that ergonomics programs that were implemented and evaluated before the effective date of the Proposed Rule must, among other things, (1) satisfy the ''basic obligation'' of each of the standard's six program elements; and (2) demonstrate that the elements of the preexisting program are ''functioning properly * * *.'' This provision is completely inadequate to assist employers with preexisting programs. The qualifications

written in to this provision essentially require that employers reconstruct their existing programs, even if any given program is effective in addressing supposed ''MSD hazards,'' so that it mirrors the Proposed Rule's notion of an appropriate ergonomics program.

[A]n employer is supposed to ensure that his program satisfies the ''basic obligation'' of each program element. The ''basic obligation'' of each [proposed] element is so broadly written that it encompasses all requirements enumerated under that particular element. Thus, employers, including those Chamber members who have [spent] a great deal of effort and money to establish voluntary ergonomics programs, will be forced to [alter] their preexisting programs to comply with the Proposed Rule (Ex. 30–1722).

Edison Electric Institute's (EEI's) comments were similar:

EEI supports the concept of a ''grandfather'' clause. However, the proposed version is more illusory than real, for it appears to require that all newly proposed controls be put in place before the effective date of the standard. It is unrealistic and unfair to ''grandfather'' only those programs that track the proposed standard. It is as if OSHA is saying, ''You don't have to do anything, provided that you have done everything.'' A true ''grandfather'' provision would give credit for effective past programs, regardless of whether those programs conform to the scheme of the proposed program (Ex. 30–3853).

The American Hotel and Motel Association gave examples of how an effective existing program might fail OSHA's proposed grandfather test:

OSHA does not allow for any variation from OSHA's regulation if a [company's] ergonomics program does not satisfy ''the basic obligation section of each program element in this standard.'' An ergonomics program that is proven to be 100 percent effective would fail if it only offered, for example, training every five years. An ergonomics program also would likely fail if it provided program evaluation only upon a report of an ergonomic injury yet did not have a reportable injury in less than three years (Ex. 30–3233).

The Center for Office Technology noted that none of the exemplary ergonomics programs that have won the Center's ergonomics award have requirements for work restriction protection, which would have been required by the proposed standard to be in place by the standard's effective date in order for a program to be grandfathered (Ex. 30–2208). Thus, the Center pointed out that these very good programs would not meet OSHA's proposed grandfather clause. The Center recommended that OSHA include in the final rule a grandfather clause that would allow any program to be grandfathered in that was reducing MSD incidence and severity rates and educating employees about how to minimize discomfort on and off the job.

The National Association of Manufacturers (NAM) and others noted that some companies have adopted effective ergonomics programs under OSHA's Voluntary Protection Program (VPP) or through corporate settlement agreements (see, *e.g.,* Exs. 30–3392, 30–3815, 30–3819, 30–4499). These rulemaking participants observed that these ergonomics programs would not be acceptable under the proposed grandfather clause even though they have been recognized as effective by the Agency in the past. NAM urged OSHA in the final rule to grant employers' existing ergonomics programs greater acceptance for grandfather status based on the results they achieve.

Similarly, Organization Resources Counselors, Inc. (ORC) noted that a recent General Accounting Office (GAO) study recommended that OSHA adopt a flexible approach in its ergonomics standard (Ex. 500–214). ORC argued that OSHA ignored this GAO recommendation in drafting the proposed grandfather clause. As evidence, ORC pointed out that even the best ergonomics programs would not qualify for status under the proposal's grandfather clause, stating:

OSHA has predicated its proposed Ergonomics Program Standard on its observations that many businesses are successfully addressing ergonomics issues using similar approaches. In recognition of this conclusion and in order to focus its own scarce resources on the areas of greatest need, OSHA has proposed a ''limited grandfather clause'' for employers with existing ergonomics programs that meet certain criteria. OSHA's proposal made numerous references to the 1997 General Accounting Office (GAO) study of several companies with ergonomics programs which found that the companies' programs reduced work-related MSDs and associated costs, and that the programs and controls selected by employers to address ergonomic hazards in the workplaces were not necessarily costly or complex. As a result, OSHA said, ''GAO recommended that OSHA use a flexible regulatory approach in its ergonomics standard that would enable employers to develop their own effective programs.'' OSHA claimed that the standard it proposed reflects this recommendation and ''builds on the successful programs that thousands of proactive employers have found successful in dealing with their ergonomic problems'' (64 FR 65770). Unfortunately, in crafting the proposed grandfather clause, OSHA ignored a major finding of the GAO report: that although there were common elements in each of the employer's programs studied, there was significant variety in the way each program element was implemented (GAO/HEHS–97163, page 4). There was no evidence in the GAO study that one method of implementation was better than another, yet OSHA has drafted a rule that makes only one program approach—OSHA's—acceptable.

* * * [A]s written, virtually no employer would qualify under [the proposed grandfather clause's] terms, rendering it a nullity. As was attested to by several industry representatives during the public hearings, even those programs that OSHA has acknowledged as being among the best in industry today would not be in compliance with the proposal. As pointed out in ORC's oral testimony, it is unlikely that any of the approximately 150 member companies of ORC's occupational safety and health groups, whose safety and health programs are among the most sophisticated and effective in the world, would meet the criteria under section 908 of the proposal. This is because of the proposed requirement that an employer must meet all of the ''basic obligation'' sections of each program element. Virtually all of the proposed ''basic obligations'' are too prescriptive and should be simplified as described more fully in ORC's written comments. In particular, many ORC employers would not meet the provisions of [proposed] sections 911, 917, 923 or 929, individually, and almost none would meet all four (Ex. 500–214).

Summing up the concerns of commenters wanting a more flexible grandfather clause, the American Dental Association argued that the proposal would reject alternative programs that might be equally or even more effective (Ex. 32–141). The Association recommended that OSHA establish a standard based on objective measures or performance and leave the methods of achieving those objectives to employers.

Several employer representatives illustrated how various effective existing ergonomics programs would fail to meet the proposed grandfather clause (see, *e.g.,* Ex. 30–4185; Tr. 8634, 9181, 11265). For example, IBP, Inc., which has a corporate-wide ergonomics settlement agreement with OSHA, identified several aspects of the proposed program that their program does not address: responses to every MSD symptom, communication with the health care provider, and WRP (Tr. 4929, Tr. 5041). In the hearings, an IBP representative stated that its program would not meet the grandfather clause because of proposed requirements in these three areas (Tr. 5041). Many other employer representatives also noted that their programs did not include provisions providing for work restriction protection and, consequently, would not qualify under the grandfather clause (Tr. 8634, Tr. 9181).

Constangy, Brooks and Smith stated that their clients could not meet the hazard control endpoints in the proposed standard (Ex. 30–4185). They argued that, as drafted, the proposal would mean that the occurrence of even a single MSD would require their clients to implement new engineering controls. Consequently, they believed that their clients' programs would not qualify under the proposed grandfather clause. Other commenters also noted that their, their members', or their clients' programs would not meet the proposed standard's grandfather clause for similar reasons (see, *e.g.,* Exs. 30–3344, 30–3347, 30–3368, 30–3845, 30–4137).

One witness at the hearing, Thomas J. Durbin of PPG Industries, noted that since no one would benefit from the grandfather clause as it was proposed, OSHA should either put in a true grandfather clause that recognizes programs containing the six core elements or eliminate it altogether (Tr. 3135, Tr. 3147). In questioning, he stated that he interpreted the proposal to require the full program as long as MSDs continued to occur (Tr. 3140).

The Boeing Company argued that the restrictive nature of the proposal's grandfather clause ran counter to the intent of the OSH Act (Ex. 30–1547). In support of their position, they pointed to section 6(d) of the Act, which provides for a variance procedure to recognize alternative approaches to compliance with OSHA standards, provided that the alternative provides equivalent employee protections. Boeing was particularly concerned that the standard, as proposed, would deny grandfather status to an employer who had a program but who had not yet completed the implementation of all of the control measures required by the proposal.

On the other hand, many rulemaking participants indicated that the proposed standard's grandfather clause would allow ineffective programs to be grandfathered (see, *e.g.,* Exs. 30–4200, 32–111, 32–182, 32–198, 32–210, 32–339; Tr. 3477). For example, the United Steelworkers of America and others were concerned that employers whose program evaluations failed to identify deficiencies simply because the evaluations were not done properly could be grandfathered in under the proposed standard (see, *e.g.,* Exs. 32–111, 32–182). They recommended that OSHA develop additional regulatory text to strengthen the program evaluation provisions. The Union of Needletrades, Industrial and Textile Employees (UNITE) was also very concerned that the proposed grandfather clause would inadequately protect employees (Ex. 32–198), stating:

> The acceptability of existing programs depends largely on the criteria used to determine acceptability. Therefore, the correctness of the current criteria—compliance solely with the ''basic obligation'' provisions—is critical to the protection of workers from OSHA's approval of programs which are in fact ineffective. For the reasons [summarized by OSHA] below, UNITE does not believe that these criteria will provide the appropriate level of workers protection (Ex. 32–198).

Several unions, including UNITE and the United Food and Commercial Workers International Union (UFCW), gave the following reasons why the proposal's grandfather clause was inadequate:

- The detailed provisions implementing each of the proposed program elements, which would not be required for grandfathered programs, are necessary for adequate protection of employees. UNITE pointed to OSHA's extensive justification for each of these proposed provisions in the preamble and indicated that the justification applied just as well to programs in existence before the rule becomes effective as to programs implemented afterward (Ex. 32–198).
- The proposed basic obligation sections for the management leadership and training elements, which would be the only requirements employers with grandfathered programs would have to meet, would allow poorly trained managers to make determinations that their program complies with the standard. The unions noted that training for managers was not included as part of the proposed basic obligation for these elements. They were particularly concerned that inadequate training of managers would result in improper program evaluations (see, *e.g.,* Exs. 30–4200, 32–198, 32–210, 32–421).
- Job hazard analysis and control and quick fixes could be performed without the input of employees because employee participation is not a part of the proposed basic obligation of those provisions.[2] The unions argued that, without feedback from employees, a provision not addressed in the proposed basic obligation for the job hazard analysis section, employers would be likely to improperly identify risk factors or select improper hazard controls (see, *e.g.*, Exs. 30–4200, 32–198, 32–210, 32–461).
- The proposed MSD management basic obligation is missing a requirement for health care professionals to be provided with information about the workplace and the employee's job (Ex. 32–198). According to UNITE, which has had first-hand experience with programs that do not require such information sharing, this omission would result in ill-conceived recommendations from the health care professional (Ex. 32–198).
- The basic obligation for the proposed job hazard analysis and control section omitted requirements that limited the use of personal protective equipment and mandated that employers provide it at no cost to employees (Ex. 32–210).
- The proposal's requirements for program evaluation were inadequate and would allow employers to overlook serious program deficiencies (see, *e.g.*, Exs. 30–4200, 32–198, 32–210). The unions believed that, because the rule's evaluation provisions are the primary means for determining the acceptability of an existing program under the grandfather clause, these provisions should be revised in the final rule to prevent employers from inappropriately approving unacceptably weak programs for grandfather status. (Also see the summary and explanation for paragraph (u), later in this section of the preamble.)

The International Brotherhood of Teamsters (IBT) observed that the proposed standard would consider any new ergonomics program coming into effect to comply with the standard as deficient if the new program did not meet one or more of the standard's requirements (Exs. 30–4200, 32–461). The IBT argued that existing programs should be held to the same standard:

> Any program grandfathered under this proposal would essentially be judged by a different set of criteria than a program developed after the effective date. The grandfathered program would be considered to be in compliance despite having missing components, provided that the [proposed] basic obligations as currently defined, are met. An identical program, that was developed after the effective date and was not grandfathered would not be considered to be fully in compliance and would be cited by compliance officers for each component of the standard that was lacking, despite meeting the very same basic obligations that the grandfathered program met. This weakness can not be used as an argument that compliance is too difficult to determine, but rather must be viewed as an argument that the grandfathering provision, as it currently stands, has serious flaws and must be significantly improved such that every worker is provided the same protections under this standard (Ex. 32–461).

At the hearing, OSHA stated that the Agency's intent in the proposal was to include a grandfather provision that recognized existing effective ergonomics programs:

> Other requirements of the proposal that OSHA has designed to be flexible include a grandfather clause that permits employers who have already implemented an

[2] UNITE also noted that the proposed quick fix section had no basic obligation section at all.

Ergonomics Program to continue to operate that program as long as it meets minimal requirements (Tr. 19).

It is readily apparent from the rulemaking record that very few, if any, existing ergonomics programs would be able to fulfill the requirements of the proposed grandfather clause. Although OSHA drafted the language in the proposed standard generally and in the grandfather clause specifically to be flexible, the Agency recognizes that the grandfather clause, as proposed, was not sufficiently flexible to allow existing programs that are effective in protecting employees from MSD hazards to be grandfathered in. On the other hand, OSHA agrees with many of the union comments, discussed above, that it is important that the grandfather clause not recognize programs that are ineffective in protecting employees from MSD hazards. OSHA has structured the final rule's grandfather clause to strike an appropriate balance between flexibility, on the one hand, and program effectiveness, on the other.

In drafting the proposed and final rules, OSHA has relied heavily on the Agency's experience with effective ergonomics programs that proactive employers have implemented; in fact, the final rule is modeled after such programs. OSHA has concluded that it is reasonable for the Agency to include in the final rule a grandfather clause that is less prescriptive than the one proposed and is more closely focused on the effectiveness of existing programs. The Agency has made several changes to the final rule's grandfather clause to achieve this end. First, OSHA has streamlined the subelements (called ''basic obligations'' in the proposed rule) under each core element and has removed some of the more prescriptive requirements. For example, the final rule has not carried forward the proposal's provision that periodic training and program evaluations in grandfathered programs be conducted at intervals of no more than 3 years. Second, OSHA is permitting employers to add or strengthen elements of their programs, provided that they do so, and evaluate the program at least once, before the effective date of this rule. Third, because so many commenters with otherwise effective programs reported that their program would not qualify for grandfather status solely because it did not have a WRP component, the final rule gives employers a year from the effective date of the standard to add such protections (which are a part of MSD management) to their existing programs. Fourth, OSHA has included, in the final rule, examples of some of the specific measures that employers may use to demonstrate that their programs are effective. These changes will enable more employers' programs to qualify for the grandfather clause but will also ensure that only effective existing programs are recognized. The changes also shift the focus from compliance with the rule to effectiveness in preventing MSDs. Although OSHA believes that having all six elements is vital to qualify a program for grandfather status, OSHA is not interested in technical compliance but in real effectiveness.

2. Whether Effectiveness of an Ergonomics Program Is All That Matters

Many rulemaking participants believed that it would be more appropriate for the standard to simply accept proven, effective programs than to require that grandfathered programs also include the core elements of successful programs (see, *e.g.*, Exs. 30–523, 30–1090, 30–1901, 30–1722, 30–2208, 30–3211, 30–3765, 30–3813, 30–3934, 30–3956; Tr. 3319, 15657). In their view, effectiveness is the only part of the program that matters, and therefore any existing program that is effective should be grandfathered. Doerle Food Services, Inc., exemplified many of these comments:

> OSHA has made its position clear, at 64 Fed. Reg. 65791, in which it states that the agency believes ''enforcement of the standard will be more consistent and more equitable * * * if the test of an employer's program is whether it contains the core elements, rather than whether it is effective.'' This is, we submit, an incredible statement, and reflects OSHA's devotion to its mandated program and ''control'' strategy, as opposed to actual effective programs. It is this outlook which is at the core of the ''grandfather'' provision, since it does not accord recognition in any meaningful way to a pre-existing effective program that can be shown to have minimized the conditions that are at issue. This portion of the standard clearly needs to be reconsidered and expanded (Ex. 30–523).

The Washington Aviation Group gave examples of how an employer's ergonomics program might be effective without meeting the proposal's grandfather criteria:

> There are a variety of reasons why a company might experience few or no ergonomics problems. The business owner may have an intuitive sense of how to promote comfort among the employees that has a beneficial effect on ergonomics issues. The nature of the work might be such that it does not lend itself to repetitive motion disorders or other ergonomics problems. Management may have established an effective rapport with the employees that is sufficiently responsive so that potential problems are generally resolved in an expedient manner before they represent hazards. While all of these are approaches that can support safety in an effective and expedient manner, none of these would represent sufficient ergonomics programs under the proposal; and that is part of the problem with the proposal: it discounts systems that work, but that are not as comprehensive or well-documented as the proposal (Ex. 30–3849).

Some rulemaking participants recommended that programs be grandfathered based solely on one or more measures of effectiveness (see, *e.g.*, Exs. 30–1901, 30–3211, 30–3344, 30–3348, 30–3361). For example, Armstrong World, Inc., recommended accepting for grandfather status programs based on the employer's injury incidence rates:

> Employers should be exempt from any proposed standard based on their performance in preventing such injuries. We would suggest using 50% of the employers' industry's respective SIC Code rates for Total Recordable Cases and Cases With Days Away From Work as a meaningful measure of accepting existing employer ergonomics processes as they are (Ex. 30–1901).

Other rulemaking participants also recommended using injury rates, either in absolute terms or in terms of showing a reduction, as a measure of effectiveness and qualification for grandfather status (see, *e.g.*, Exs. 30–3344, 30–3348, 30–3361). For example, the Exxon Mobil Production Company suggested that the standard grandfather a program if the employer's records demonstrate that the program is preventing MSDs and is managing ergonomic concerns (Ex. 30–2433). John W. Braddock suggested that employers be permitted to produce evidence that the existing program was working and that there is an effective early reporting mechanism in place and to qualify for grandfather status on this basis (Ex. 30–4301).

ORC argued that there are a number of ways to measure program effectiveness, which should be the true gauge of the worthiness of any ergonomics program (Ex. 30–3813; Tr. 4112). They suggested several possible ways to measure effectiveness:

> OSHA might place the initial burden of demonstrating effectiveness of the program on the employer and include in a non-mandatory appendix a number of types of performance measures and approaches that OSHA would consider appropriate. OSHA mentions some in the preamble, *e.g.*, decreases in the numbers or rates of MSDs and decreases in severity. Other measures might include reduced workers' compensation claims for MSDs, use by the employer of periodic symptoms surveys and other indicia of effective early reporting, or

demonstration that risk factors have been reduced and/or tools and equipment have been modified. An employer might demonstrate effectiveness based on periodic program evaluation that measures effectiveness based on an internal ''score card'' that looks at a number of appropriate effectiveness measures.

* * * * *

ORC believes strongly that OSHA should be focusing its attention on results or performance, not methodology (Ex. 30–3813).

However, even though ORC objected to the proposed grandfather clause's emphasis on core elements and their basic obligations, they did agree with OSHA that there is a need to ensure that any demonstration of effectiveness that relies on numbers or rates of MSDs not mask any underreporting of MSDs (Exs. 30–3813, 32–78).

Unisea, Inc. suggested the following language for OSHA to use in the final rule to recognize existing ergonomics programs based on effectiveness:

If a company is able to show by operation redesign with ergonomics considerations made, or injury records or near-miss reports that a reduction of reported MSD's has occurred, that company shall be considered in compliance of the standard and its intent.

OR, If a company is able to show a steady overall reduction of injuries, either by total number or incident rate, that company shall be considered in compliance of the standard and its intent (Ex. 500–158).

Abbott Laboratories argued along similar lines and submitted data in support of its position. According to a comment in the record, Abbott Laboratories instituted ergonomics programs at three laboratories in the late 1980's (Ex. 500–153). Abbott's comment presented the OSHA-recordable illness rates at those facilities over the last 9 years. These data are shown in Table 2. Abbott states that the fall in rates over that period reflected ergonomic improvements made at each facility and should qualify these establishments for grandfather status.

TABLE 2.—OSHA RECORDABLE ILLNESS CASE RATES AT THREE ABBOTT LABORATORIES PLANTS

Year	Plant A	Plant B	Plant C
1999	1.03	1.44	1.46
1998	0.47	1.90	2.87
1997	1.02	1.81	2.50
1996	0.43	1.00	2.30
1995	0.71	3.27	2.74
1994	2.69	3.13	3.47
1993	3.70	4.27	4.51
1992	3.25	2.52	6.68
1991	4.41	4.54	7.06

Source: Ex. 500–153.

Another point raised by commenters concerned the proposed requirement that grandfathered programs must be in place and be judged effective by the time the standard is effective in order to be grandfathered. The Departments of Defense and Navy recommended that the standard provide employers wishing to grandfather their programs in with sufficient time to conduct a statistically significant evaluation of the effectiveness of the program even if the evaluation did not take place until after the effective date (Ex. 30–3818; Tr. 3228). They were concerned that it would not be possible to perform such an evaluation before the effective date of the standard, as the proposal required. In addition, they suggested that the standard clarify what effectiveness measures or evaluation points OSHA would accept for each program element in grandfathered programs (Ex. 30–3818; Tr. 3228).

Other commenters suggested a variety of indicators of program effectiveness. For example, the American Industrial Hygiene Association (Ex. 32–133) stressed measures of effectiveness other than injury rates:

OSHA needs to be more specific on what constitutes an equivalent program so that mediocre programs do not pass compliance, but programs showing improvements will have a reasonable chance to be considered acceptable. The evaluation of quality of the program should rely on real evidence of hazards identified and risk reduction. Specifically, have physical risk factors been reduced and have ergonomics improvements been made? Indeed, this is the ''bottom line.'' Other things to look at include whether training has been done, and if there is a reduction in MSDs and associated workers' compensation costs (Ex. 32–133).

Herman Miller, Inc., listed several measures that employers could use to measure effectiveness: ''Reduction in MSD hazards, MSD severity rates, lost workdays or benchmarked improvements in employee satisfaction rates'' [Ex. 30–518]. They suggested leaving the specific protocol to the discretion of the employer and noted that OSHA compliance officers would need to be given proper training and tools so that they could make logical and qualitative assessments of ergonomics programs and determine whether they were effective enough to qualify for grandfather status.

Dennis Morikawa, testifying on behalf of Morgan, Lewis and Bockius, did not specify a particular measure of effectiveness but recommended instead that OSHA make the grandfather clause widely available to employers to encourage as many of them as possible to adopt programs before the final rule's effective date (Tr. 15657). He argued that this approach would further OSHA's real goal: The reduction in the number of MSDs experienced by workers.

In their post-hearing submission, the U.S. Chamber of Commerce criticized the proposed grandfather clause's reliance on the proposed core elements' basic obligations instead of effectiveness:

The Agency claims that existing programs will be evaluated upon the existence of the core elements rather than a program's effectiveness * * * because it will make such evaluation ''less time-consuming'' and ''administratively simpler'' for both OSHA and the employers. 64 Fed. Reg. at 65791. Of course, the real reason that the Agency has chosen to focus on content is that OSHA simply cannot judge effectiveness and has no idea what it means to be an effective program. Indeed, in order to qualify under the Grandfather Clause, an employer's existing program must not only contain the core elements of the Proposed Rule, but must also be ''functioning properly.'' And although according to the Preamble ''effectiveness'' is not a measure of whether or not the program is ''functioning properly,'' 64 Fed. Reg. at 65791, Marthe Kent testified to precisely the opposite effect:

And further [proposed 1910.908], which says the evaluation indicates that the program elements are functioning properly, what we mean there is [that the elements] are effective. I mean, you cannot have a program with the elements functioning properly and it not be effective.

Tr. at 1–182. Thus, not only can the Agency not determine what ''effectiveness'' means, it also apparently cannot decide whether or not ''effectiveness'' means the same thing as ''functioning properly.'' Until the Agency sorts out this conundrum in some understandable way, there can be no real Grandfather Clause in the Proposed Rule (Ex. 500–188).

OSHA did not propose a grandfather clause that relied heavily on injury rate goals to demonstrate effectiveness because, as the Agency noted in the proposal (see 64 FR 65980 *et seq.*), MSDs are currently substantially underreported, and relying on reported rates would therefore, in many cases, overstate effectiveness. Some commenters, however, argued that MSD rates were appropriate for this purpose (see, *e.g.,* Exs. 30–2989, 30–3845). For example, the Forum for a Responsible Ergonomics Standard stated:

If OSHA is concerned with how to measure ''effectiveness,'' it can prescribe the manner in which effectiveness is to be measured, such as reductions in the number and severity of MSDs. OSHA contends, however, that most means of measuring ''effectiveness'' have built-in incentives to discourage reporting. See *id.* This contention ignores the fact that companies are subject to regulatory requirements in the proposed rule, backed up by OSHA fines and penalties, to facilitate employee reporting (Ex. 30–3845).

A. O. Smith Corporation commented that, in its experience, few employers discourage reporting of workplace injuries:

> The provisions in the standard that allude to the employer having programs in place that discourage the reporting of MSD injuries tends to suggest that entire safety and health awareness and accident prevention programs would be construed as disincentives to reporting. We do not accept this premise and find that most employers work hard at making sure their employees are provided a safe work environment and a mechanism to report injuries should they occur (Ex. 30–2989).

Other rulemaking participants agreed with the approach taken in OSHA's proposal and opposed basing the grandfather clause solely on a measure of the reduction in the number of MSDs in a workplace (see, *e.g.*, Exs. 30–2387, 32–339, 500–207). For example, the AFL–CIO stated that the elements that OSHA included in the proposal's grandfather clause are widely recognized as the basic elements of an effective program (Ex. 32–339). The International Brotherhood of Teamsters argued that, to be grandfathered, an existing program needed to be comprehensive and to provide workers and their representatives with full information and rights of participation in addition to being effective in reducing the number of MSDs (Ex. 500–207).

In response to these comments, OSHA finds that the record evidence demonstrates that the Agency should emphasize the effectiveness of grandfathered programs much more in the final rule than it did in the proposal. Record evidence also demonstrates that the core elements are essential to effectiveness (see the discussion of the core elements below). If a program is not demonstrably effective in protecting employees from MSD hazards, OSHA believes that such a program should not qualify for grandfather status and should instead have to comply with all the requirements of the final rule. On the other hand, if an existing ergonomics program has the core elements and is truly effective in protecting employees, it merits grandfather status. The central question then becomes how to measure effectiveness; if effectiveness measures are not carefully chosen, ineffective programs will be grandfathered in and the employees in the establishments covered by such ineffective programs will be inadequately protected.

One widely used method of measuring effectiveness is the tracking of MSD incidence and severity rates. However, MSD incidence and severity rates can be misleading if efforts are not made to ensure that the rates reported are accurate and that the use of such rates is appropriate for the workplace. Some of the problems with various objective measures of effectiveness are described below.

(a) *Incidence rates are dependent on accurate reporting.* An employer's recordkeeping system must accurately count work-related MSDs if incidence rates are to be a meaningful index of effectiveness. An employer whose employees are reluctant to report, or one who does not record all MSDs, will appear to have a lower incidence rate than a comparable employer with an accurate recordkeeping system, and the incidence rate in the first employer's establishment will bear no relationship to program effectiveness. There are many reasons why MSDs are underreported (see the discussion of this issue in the summary and explanation for MSD management). If there are disincentives to reporting, employees may not report all MSDs. If an employee is not well informed about MSD signs and symptoms, he or she probably will not realize that the signs and symptoms of an MSD are work-related and will fail to report them. Employees also fail to report MSDs in some cases because they do not want to submit a claim to the workers' compensation system. Thus, incidence rates must be used with care.

(b) *Severity rates are dependent on consistency in return-to-work policies.* Severity rates are typically measured in terms of days away from work or days on restricted duty. Changes in how employers treat injured workers can affect severity rates. For example, if an employer who has traditionally measured severity in terms of lost workdays institutes a new policy of placing employees with MSDs on restricted duty rather than removing the employee from work, the number of days away from work will decrease. Thus, severity rates must also be used carefully to ensure that they are not reflecting a change in the employer's MSD management process rather than a true decrease in MSD severity.

(c) *The randomness inherent in injury and illness statistics may make incidence rates an unreliable indicator of effectiveness.* Injuries and illnesses are events that occur based on probability. In other words, hazards do not automatically lead to injuries or illnesses; the presence of hazards simply increases the probability that an injury or illness will occur. Just as a coin flipped 10 times will not automatically land heads up 5 times, a workplace with an average MSD incidence rate of 19.3 per 1000 employees [3] will experience an MSD incidence rate that varies about that number from year to year. If employee exposure to MSD hazards at this workplace remains relatively constant, the actual incidence rate in any one year (assuming that the number of employees and other factors also remain constant) will probably be reasonably close to that value. In one year, for example, 17 of the 1000 employees could suffer an MSD, while in the next year, 21 might be injured. This variability can be seen in the Abbott Laboratories data in Table 2, especially in the last 5 years, after the program had matured.

Variability is even more pronounced in a workplace with few employees. If the employer in the earlier example had 10 full-time employees and the same overall average MSD incidence rate, the establishment could be expected to have 0, 1, or 2 MSDs in a given year.[4] The corresponding incidence rates per 1000 employees, however, would be 0, 100, and 200. If incidence rates alone were used as the measure of effectiveness at such a facility, the program would be rated very effective in one year and in need of major correction in the other years.

In the context of the grandfather clause, this year-to-year variability poses problems for OSHA and for employers. If the final rule were to identify a specific rate as the sole criterion for grandfathering existing programs, then an employer whose program was acceptable one year might be unacceptable the next simply as a result of this variability. For example, suppose that the final rule selected 1.45 as the maximum acceptable incidence rate for a grandfathered program. Abbott Laboratories Plant A (from Table 2) would have had an acceptable program in terms of grandfathering since 1995 (Ex. 500–153). Abbott's Plant C program (from Table 2) would never have met the incidence rate limit in this period and would therefore have had to comply with the ergonomics standard. Abbott's Plant B (from Table 2) could have had its program grandfathered in 1996 and 1999, but would have had to comply with the standard in 1997 and 1998. From this example, it can be seen that some employers' programs, after initially qualifying for the grandfather

[3] This is the overall MSD incidence rate for SIC 283.

[4] It would take 100 years for this firm to have 1000 employee-years of experience. If the employer had an incidence rate of 17 MSDs per 1000 full-time employees, the employer would see 17 incidents over 100 years. Over that period, in most years, no MSDs would occur. In other years, one or maybe two MSDs would occur.

clause, would subsequently be required to comply with the ergonomics standard in at least some years.[5] This ''sometimes in and sometimes out'' phenomenon is not what OSHA or employers with existing ergonomics programs want from a grandfather clause.

Alternatively, the final rule could mandate that, to be grandfathered, the employer's MSD incidence rates had to decrease over time, as suggested by some rulemaking participants (see, for example, the comments of Unisea, Inc., Ex. 500–158, above). Again, the Abbott Laboratories data in Table 2 show that this approach would also be problematic (Ex. 500–153). All three of Abbott Laboratories' plants experienced increasing rates in some years in the period reported. Although the overall trend over the full 9-year period is downward for all of the Abbott plants, this is not the case for all time periods. For example, Plant C's incidence rates went up over the 4-year period from 1995 to 1998 (see Table 2). In fact, OSHA's experience is that, as an employer's ergonomics program matures, incidence rates begin to level off, albeit at a much lower rate than before the program was established (see Chapter IV of the Economic Analysis).

Other ''objective'' measures of effectiveness recommended by rulemaking participants (see *e.g.*, Ex. 30–3813; Tr. 4112) pose similar problems. Decreases in the rate of workers' compensation claims have the same problems as incidence rates when they are used as effectiveness measures. Symptom surveys, although valuable as an early reporting tool, vary from one workplace to another and therefore cannot be used for different sites. Reductions in employee exposure to MSD hazards is a good measure of whether an ergonomics program is working but, OSHA has no benchmark that adequately describes the performance of an effective program. Without a benchmark, reductions in employee exposure to MSD hazards cannot be used as the sole criterion for grandfathering programs at different sites.

In addition, OSHA has concluded that the core elements (management leadership and employee participation, hazard identification and assessment, hazard prevention and control, MSD management, training, and evaluation) are essential to a properly functioning ergonomics program. These elements are included in the safety and health programs recommended or used by many different organizations (the ergonomics standard uses slightly different terminology for some of these elements):

- OSHA's VPP, SHARP, and consultation programs;
- The safety and health programs mandated by 18 states;
- The safety and health programs recommended by insurance companies for their insureds (many of which give premium discounts for companies that implement these programs or impose surcharges on those that do not);
- The safety and health programs recommended by the National Federation of Independent Business, the Synthetic Organic Chemical Manufacturers Association, the Chemical Manufacturers Association, the American Society of Safety Engineers, and many others;
- The strong recommendations of OSHA's Advisory Committees (NACOSH, ACCSH, and MACOSH), which consider these program elements essential to effective worker protection programs.

OSHA also is including WRP, or equivalent protections against wage loss, as a requirement for all programs (both those that are grandfathered and those complying with the standard) because, without it, OSHA believes that many employees will be reluctant to report their MSDs because they fear economic loss. There is strong evidence that such underreporting is currently taking place, as well as evidence that protecting workers from wage loss increases reporting (see the discussion of underreporting in the summary and explanation for MSD management). OSHA's purpose in including a WRP provision, both in the grandfather clause and in the standard, is to ensure employee participation and free and full reporting of MSDs and MSD hazards. Effective ergonomics programs depend on such reporting, and the standard also depends on employee reporting for its effectiveness. Absent such reporting, no ergonomics program will achieve its worker protection goals.

For these reasons, OSHA has concluded that quantitative effectiveness measures alone cannot be the sole basis for judging whether an employer's program should be grandfathered. The Agency's experience over the last two decades, and that of private industry and insurance companies, is that safety and health programs, and ergonomics programs, containing the core elements are effective in lowering injury and illness rates. These programs work because they involve everyone in the organization in finding and fixing hazards. They also establish two-way communication in the form of reporting and response systems. OSHA finds that the core elements are essential to effective ergonomics programs, and the record provides ample evidence of this (see the discussion below on whether the core elements are necessary). Employee participation, for example, is a prominent component of the programs of many leading companies (see, *e.g.,* Exs. 32–77, 32–185, 32–210; Tr. 4973, Tr. 5339). The core elements also help to ensure that employees are reporting their MSDs, that management is responding to these reports, that jobs are being analyzed and fixed, and that the program is functioning as it should. The core elements thus help to ensure that programs are not focusing too heavily on quantitative measures of effectiveness, which, as the discussion above shows, are often misleading.

OSHA agrees, however, that effectiveness measures can be useful in determining the degree to which an ergonomics program is working. Employers and authors of effectiveness studies routinely rely on them as evidence that an ergonomics program is having a positive effect. Of the measures available, incidence and severity rates are most commonly used and were most often recommended in the rulemaking record (see, *e.g.,* Exs. 30–1901, 30–2208, 30–3344, 30–3348, 30–3361). If one of these measures is used, the employer must take care to ensure that the calculated incidence or severity rate accurately reflects conditions at the workplace. First, the effectiveness measure chosen must be appropriate for the size and nature of the workforce and the employer's MSD experience. For example, as explained earlier, an employer with few employees will not find incidence rates useful to measure effectiveness. Instead, such employers could examine whether employee exposure to MSD hazards has been reduced. Second, the employer must check to ensure that some MSDs are not going unreported. If employees are failing to report MSDs, the employer's calculated incidence and severity rates will not accurately reflect the injury experience at the workplace. Third, the employer should check rates over a variety of periods to ensure an overall downward trend in the data. Looking at data over a single period can be misleading.

OSHA finds, based on the evidence in the record as a whole, that reliance on both qualitative (the core elements) and quantitative (effectiveness measures) components will best assure that any program that is grandfathered deserves this status and will continue to operate

[5] Using a rolling average incidence rate would help smooth out, but would not eliminate the year-to-year variability.

effectively in the future. Consequently, the final rule's grandfather clause requires that grandfathered programs contain the core elements of effective ergonomics and be demonstrably effective. Employers may use any of a broad range of measures, including reductions in the number or severity of MSDs, increases in the number of jobs in which ergonomic hazards have been controlled, reductions in the number of jobs posing MSD hazards to employees, or any other measure that demonstrates program effectiveness to meet the grandfather clause's requirement for a demonstration of program effectiveness.

3. Whether the Core Elements Are Necessary

Some industry representatives objected to the proposed requirement that grandfathered programs contain all the core elements of the proposed standard (see, *e.g.,* Exs. 30–1722, 30–3853, 30–3956; Tr. 5699). They argued that any program that was effective in reducing MSD rates should be accepted for grandfather status, even if it did not include all the core elements.

For example, the Washington Legal Foundation was particularly concerned that employee participation was proposed as a required component of grandfathered programs and of the program required by the standard (Tr. 11265). They argued against mandatory employee participation:

OSHA's proposed ergonomic standard perhaps more so than any other standard mandates full employee involvement in every aspect of its requirements.

In many ways, the proposed standard places employees in the driver's seat.

Certainly many companies have determined that a [cooperative] relationship with their employees is beneficial on both a safety and a production level.

Other companies, however, have reached a different conclusion. And certainly, the conclusion to be reached may differ depending on the type of work involved, the size of the company, the characteristics of the work force, and other factors.

The Washington Legal Foundation does not believe that it is its place to determine that some of these [employers] are right and others are wrong nor is it the place of the federal government to mandate a specific mode of employer/employee relations (Tr. 11265).

On the other hand, some union representatives argued strongly in favor of the core elements (see, *e.g.,* Exs. 32–210, 32–461, 500–218). The International Brotherhood of Teamsters noted that they had worked with various employers through the collective bargaining process to address ergonomic hazards and that some employers' programs took a piecemeal rather than comprehensive approach to the problem and should therefore not be granted grandfather status (Exs. 30–4200, 32–461). The UFCW argued that the proposed core elements are recognized as the basic elements of a good ergonomics program (Ex. 32–210). They presented their experience with successful ergonomics programs as follows:

The six elements OSHA is proposing in the ergonomics program standard are included in all successful company programs! Further, the experience of the myriad of companies who have successfully tackled the problem through these elements attests to the feasibility of the methods. The settlement agreements OSHA has entered into with IBP, Sara Lee, Cargill, ConAgra Poultry, John Morrell & Co., Empire Kosher, Marshall Durbin Companies, National Beef, Worthington Packing and Tyson Foods contain these six elements—all work, and all are feasible. Many of the companies used ergonomists, they analyzed the jobs and developed engineering solutions to address the most egregious jobs. They developed medical protocols so that workers can get to treatment early rather than waiting until they were crippled and needed surgery. They protect workers wages and benefits when they report MSDs. And in our represented companies, all this included the union in a fundamental way. In order to be effective, ergonomics programs by their very nature must be participatory and include workers at many levels, including those that do the problem jobs (Ex. 32–210).

Mr. Bawan Saravana-Bawan, a representative from the Canadian province of British Columbia, described how that province handled existing programs when its ergonomics standard came into effect (Tr. 14260). He stated that existing programs needed to incorporate any missing elements in order to be accepted. On the basis of his experience, he stated that any ergonomics program needed to have all the core elements (management leadership and employee participation, information dissemination, hazard identification, hazard assessment and control, training, and program evaluation) to be successful.

The Department of Defense (DoD) also argued that the program elements are essential. The DoD noted that the success of their program is due to the elements of the program, including, in particular, management leadership, employee participation, hazard prevention and control, and monitoring injury records and responding to potential problem areas (Ex. 30–3826).

OSHA has concluded that it is essential for ergonomics programs, whether grandfathered or not, to address all of the core elements: Management leadership and employee participation, hazard information and reporting, job hazard analysis and control, training, MSD management, and program evaluation. (The Agency has presented evidence supporting each of these core elements in the summary and explanation for the corresponding provisions of the standard, below.) Further, the Agency finds that it is as important for a grandfathered program to include all of the core elements as it is for a program brought into existence to comply with the final rule to include these elements. Although some commenters, as discussed above, argued that a program could be effective without all of the core elements, OSHA finds their arguments unpersuasive, based both on the record and the Agency's own experience with successful programs.

The Agency believes that the core elements provide assurance that the program will work as intended—management leadership will ensure that the program has the continued backing of management, which is essential to continued success; employee participation in the program will help ensure that ergonomic hazards do not go undetected; hazard information and reporting will ensure that employees are informed about MSD symptoms and how to report them so that work-related MSDs are not ignored; work restriction protection helps to ensure that workers report signs and symptoms as early as possible; job hazard analysis and control are needed to ensure that ergonomic hazards are found and abated; MSD management is necessary so that MSDs are managed appropriately and injured employees get well as soon as possible; and program evaluation is necessary for the correction of deficiencies in the program. Without the checks and balances the core elements provide, OSHA believes that ineffective programs may be judged effective on the basis of an inappropriate measure, and once-successful ergonomics programs could deteriorate over time and leave employees unprotected.

Some rulemaking participants agreed that grandfathered programs should include the core elements but argued that compliance with the proposed basic obligation sections for each core element was not essential to having an effective program (see, *e.g.,* Exs. 30–1294, 30–3813, 30–3723, 30–3765). These commenters believe that many employers have effective programs that would not be recognized by the proposed standard because they would not meet the proposed basic obligation sections. ORC reflected the thrust of these comments as follows:

Equally important, contrary to OSHA's contention in the preamble, the ability of an employer to continue applying an existing program should not be based on whether the ''basic obligation section of each program element in this standard'' is satisfied. OSHA has provided no objective evidence that the requirements of the proposed standard will be any more effective than other programs already in place. There is certainly no basis for compelling an employer to rework an effective program to force it to meet the specifics even of the proposed basic obligations (Ex. 30–3813).

Dow, ORC, and others suggested that OSHA simply require grandfathered programs to address the six basic elements of the program instead of requiring them to meet the proposal's full basic obligation for each core element (see, *e.g.,* Exs. 30–2134, 30–2725, 30–3171, 30–3765, 30–3813, 32–77). ORC noted that the proposed work restriction protection requirements were particularly troublesome, since ''[v]irtually none of ORC's member companies, whose ergonomics programs are among the most sophisticated and effective in the country, would meet this requirement * * *'' (Ex. 30–3813). Dow was concerned that the language in the proposal would not recognize their program, which is tailored to fit their management structure. They stated:

The so-called Grandfather clause that OSHA has proposed is so demanding in its requirements that companies that have existing and successful ergonomics programs, such as Dow, will not be able to take advantage of this provision to maintain their current programs. The Grandfather clause is so limited that already functioning and successful programs, tailored to the needs of a particular company, business or workplace, will not be able to satisfy the requirement. For example, in Dow's case, we would not be able to satisfy the extensive recordkeeping requirements or elements of the WRP section (since it goes beyond that required by Workers' Compensation laws.) Similarly, given Dow's management structure, we would not satisfy OSHA's communication and training requirements wherein they intend a more archaic management structure, such as one having ''supervisors'' and the like, than what Dow utilizes. So even though Dow has had a successful ergonomics program for years and has a lower than average MSD incidence rate, we would have to scrap our efforts and use a program which will not fit our needs or management structure, just to comply with this standard. Dow believes this is unacceptable.

Instead, Dow urges OSHA to delete the proposed Grandfather clause and replace it with a provision that allows for an ''acceptable'' or ''appropriate equivalent'' program. Such a concept is not foreign to OSHA or the regulated community as other OSHA standards, such as the Process Safety Management (''PSM'') standard, utilize this concept so that companies that have existing programs that are functioning successfully can continue to use them. This concept also allows companies who may not yet have an existing program to create one tailored to their own needs, rather than use a more ''one size fits all'' program as envisioned by this proposal. ''Acceptable (or appropriate) Equivalence'' would include those programs who have the basic elements of a program, but not all the mandated details or documentation. Such a concept embodies ''performance-oriented mandates'' at their best as they allow an employer to employ those methods of prevention that best meets the needs of its particular workforce and/or workplace. OSHA should only be concerned with the results (*i.e.* lower injury rates) rather than the methodology a particular employer used to obtain that goal (Ex. 30–3765).

At the hearing and in their notice of intention to appear at the public hearing, Dow described their ergonomics program and detailed how they believe their program would fall short of the proposal's requirements (Ex. 32–77; Tr. 5339). Dow expressed concern that, although their program meets the spirit of the proposed standard, it would not meet the letter of the law.

In response to Dow's concern, OSHA reviewed the perceived discrepancies between the proposed rule and Dow's description of their program. In every respect except one, Dow's program would have satisfied the proposed grandfather clause; the discrepancies Dow was concerned about were apparently the result of misinterpretation rather than deficiencies on the part of Dow's program. For example, Dow stated that, in its program, employees report MSDs using the company's existing injury and illness reporting system rather than a separate system set up just for MSDs; Dow evidently believed that a separate system would have been required by the proposal (Ex. 32–77; Tr. 5340). However, the proposed standard would not have required employers to set up a separate system for reporting MSDs as long as their existing system included a system for the reporting of MSDs. On the other hand, Dow was correct in stating that their program did not include the proposed work restriction protection provisions and would therefore not have been eligible for grandfather status under the proposed rule.

In its post-hearing submission, Edison Electric Institute argued that the specificity of the proposal's basic obligations is counter to the goal of flexibility, and the Institute recommended that the final rule reduce the detail in the basic obligation sections to allow employers greater latitude (Ex. 500–33).

The Mead Corporation suggested that, if the Agency's safety and health program rule was not promulgated before the ergonomics rule, OSHA should alter the grandfather clause in the ergonomics rule in one of two ways: (1) Make the basic obligations less prescriptive and detail acceptable alternatives for prevention-oriented programs, or (2) permit employers with effective programs to maintain them without making sweeping changes (Ex. 30–2216).

On the other hand, the AFL–CIO argued that the standard should require employers to meet the proposed basic obligations for each core element before being grandfathered in (Ex. 32–339; Tr. 3477). The AFL–CIO pointed out, however, that the basic obligation sections for several of the proposed core elements left out important requirements that were included under the core elements:

The AFL–CIO believes that employers with existing programs should be permitted to continue with these programs if they are comprehensive, provide workers and their representatives full information and rights of participation, and are effectively reducing MSDs and exposure to hazards. However, as proposed, the ''grandfather'' provisions are deficient in a number of respects and will permit employers to continue programs that do not provide adequate protection.

First, the [proposed] basic obligation requirements which all programs must meet, exclude a number of elements that in our view are essential for an effective program. For example:

- The [proposed] basic obligation section for Hazard Information and Reporting * * * does not [include] any requirement to provide employees information about MSD hazards.
- The [proposed] basic obligation on training * * * excludes any requirement for training supervisors or individuals responsible for the ergonomics program, thus permitting programs to be ''grandfathered'' even if persons responsible for the program do not have the necessary training. The basic obligation for training also fails to provide for job specific training on MSD hazards and control measures.
- The [proposed] basic obligation for Medical Management * * * does not require that medical evaluations be conducted by a health care provider.
- The [proposed] basic obligation for Program Evaluation * * * does not require consultation with employees in problem jobs or their designated representatives to determine their views on the effectiveness of the program (Ex. 32–339).

As noted earlier, other rulemaking participants also urged OSHA to strengthen the proposed basic obligations sections (see, *e.g.,* Exs. 30–4200, 32–198, 32–210, 32–461). These commenters criticized the proposed rule's lack of basic obligation requirements for the training of managers and for employee participation in job hazard analysis and control. UNITE decried the omission from the proposal of a requirement for the health care provider to be furnished with information about the workplace and the employee's job (Ex. 32–198). Another commenter objected to the omission from the proposal of requirements that limited the use of personal protective equipment and required employers to provide it at no cost to employees (Ex. 32–210).

Another group of commenters were particularly concerned about the fact that the proposal would not have permitted their otherwise excellent programs from being grandfathered because they did not have work restriction protections now (see, *e.g.,* Ex. 30–3723, 30–3765, 30–3813). SBC Communications, Inc., represented those who opposed the proposed grandfather clause's requirement for work restriction protection:

> In order to meet the grandfather clause, a company must have a ''functioning properly'' Wage Protection Program. Through our extensive research and benchmarking, no company has this element to their ergonomics program. Nor did OSHA provide any evidence of the Wage Protection Program being trialed, researched, and/or tested at a company. OSHA has made it nearly impossible for any company to meet the requirements of the grandfather clause (Ex. 30–3723).

On the other hand, the AFL–CIO noted that the hearing testimony demonstrates that some employers do currently provide wage protection for employees who suffer MSDs:

> The hearing record shows that some employers indeed are maintaining the full wages of workers who are put on medical restrictions as a result of MSDs (Tr. 16014, Tr. 14357) (Ex. 500–218).

The General Electric Company argued that employers who have employee involvement and an environment free of barriers to reporting should not be required to follow the rule's requirements for WRP (Ex. 30–1071). Novartis Corporation went further, suggesting that the entire MSD management element be removed from the standard (Ex. 30–3092). They also recommended that compliance with the endpoint provisions not be a condition for grandfathering existing programs.

The AFL–CIO recommended that OSHA permit existing programs without work restriction protection to be grandfathered as long as the employer incorporates such protections into the ergonomics program before the effective date of the standard (Ex. 500–218). They believed that this would help alleviate the concerns of employers whose programs were missing only that one element.

Although the AFL–CIO provided evidence that some employers do provide wage protection for their employees, OSHA believes, based on the record, that very few employers' existing ergonomics programs incorporate work restriction protection in the form required by the proposed standard. Despite the fact that many employers have policies (such as sick leave, short-term disability, and so on) that assure employees that they will not experience economic loss if they are injured, the record of this rulemaking indicates that many workers fear they will lose wages and benefits if they report their injuries (see the detailed discussion of the record in the summary and explanation for paragraph (r) below). The Agency therefore concludes that grandfathered programs must protect against such loss if they are to achieve the early reporting that is essential to program success. Consequently, in paragraph (c)(2) of the final rule, OSHA is allowing existing ergonomics programs that otherwise meet the criteria of the grandfather clause up to an additional 12 months to adopt an MSD management policy, including work restriction protection. The MSD management policy must meet paragraphs (p) through (s) of the final rule. The MSD management requirements in the final rule contain many inter-related provisions that are key to a successful ergonomics program. (See the summary and explanation for paragraphs (p) through (s) of the final rule.) The Agency has concluded that, because of the many interdependencies in final rule paragraphs (p) through (s), employers need to follow all of the detailed requirements of those paragraphs. However, to ensure that existing programs will still be able to qualify for grandfather status even if they do not meet the final rule's MSD management requirements, OSHA is allowing employers up to a year to meet those provisions.

Based on a review of the evidence in the record, OSHA has concluded that the proposed standard's basic obligation requirements failed to provide employers with effective existing programs sufficient flexibility with regard to grandfather status. Accordingly, in paragraph (c)(1) of the final rule, OSHA has not carried forward the proposed requirement that employers' programs satisfy the basic obligation of each element and instead requires that those programs simply contain the core elements and certain subelements, which the Agency has pared to the minimum necessary to ensure the continued effectiveness of grandfathered programs. In particular, OSHA has streamlined and made more flexible the provisions that rulemaking participants claimed were most problematic such as the employee participation and WRP provisions. OSHA also has placed the required subelements in the text of the grandfather clause itself rather than in the basic obligations sections for each of the core elements, as proposed. OSHA believes that these changes will make the core elements that grandfathered programs must currently have as flexible as possible while still ensuring that the basic components that make each core element effective are present.

In addition to considering the comments of industry representatives objecting to the core elements and their subelements, OSHA has reviewed the list of subelements that several labor organizations believed were essential to determine whether they should be included in the final rule's grandfather clause requirements (Exs. 32–198, 32–339; Tr. 3477). The Agency has included several improvements in the final rule's grandfather clause as a result of this review. First, the grandfather clause's training element now contains a requirement that employees be trained in MSD risk factors (see paragraph (c)(1)(iv)). This provision ensures that employees will be informed of MSD hazards in their workplace. Second, OSHA has added a requirement for the training of managers and supervisors to this core element. Third, OSHA has included language specifically requiring employees to be involved in program evaluation to the core element for employee participation (see paragraph (c)(1)(ii)). These additions will help ensure that ineffective programs are not accepted under the grandfather clause.

The remaining suggestions from these commenters, such as UNITE's recommendation to include a requirement for the health care provider to be furnished with information about the workplace and the employee's job (Ex. 32–198), have been accommodated by paragraph (c)(2) of the final rule. Existing programs need not currently have MSD management as a core element in order to qualify for grandfather status. However, grandfathered programs will need to add an MSD management element meeting paragraphs (p) through (s) within 1 year after the final standard's effective date. Thus, grandfathered programs will have to meet the same MSD management requirements as programs that are not grandfathered.

4. Whether the Language of the Grandfather Clause Is Vague

Some rulemaking participants argued that the language in the proposed grandfather clause was vague (see, *e.g.,* Exs. 30–494, 30–2208, 30–3922, 30–4467; Tr. 16470). They thought that this language would make it difficult for an employer to determine if he or she qualified under the grandfather clause. For example, Dennis Morikawa of Morgan, Lewis, and Bockius stated:

> These vague requirements do not inform employers which ergonomic programs OSHA would accept. Specifically, OSHA does not explain what a ''basic obligation'' is; nor does the Proposed Rule specify the level of detail employers must achieve when they attempt to comply with a basic obligation. Moreover, the grandfather clause does not make clear whether an effective, existing program without a single-incident trigger would be acceptable. For example, if programs that satisfy the CAL/OSHA standard discussed above would be accepted under the grandfather clause, then most companies would seek to design and install ergonomics programs before the effective date of the new Proposed Rule. But if a two-incident trigger would not satisfy a ''basic obligation,'' employers would be forced to re-design existing programs in order to meet the Proposed Rule, thereby creating a double standard of compliance. This, of course, would effectively eviscerate the notion of a grandfather clause. OSHA needs to specify which aspects of the Proposed Rule would be considered basic obligations, and the amount of attention to detail that employers must pay when adhering to these basic obligations. Without an assurance from the agency that an adherence to basic obligations would not require major overhauls of effective programs, the grandfather clause is illusory (Ex. 30–4467, p. 13).

Some rulemaking participants stated that the vagueness of the grandfather clause would force employers to refer to the more detailed provisions of the standard to understand their compliance obligations (see, *e.g.,* Exs. 30–494, 30–4340). They argued that the effect of this vagueness would be that employers would be forced to comply with the entire standard, which would render the grandfather clause useless.

Even some of those who supported OSHA's proposal in general agreed that the proposed grandfather clause was vague (see, *e.g.,* Exs. 30–4538, 32–210). These rulemaking participants and others urged the Agency to provide compliance assistance material, such as flowcharts, checklists, and other tools, to help employers determine whether their programs qualified under the grandfather clause (see, *e.g.,* Exs. 30–4538, 32–210, 32–339, 500–207). For example, the International Brotherhood of Teamsters stated:

> [W]e strongly urge OSHA to provide checklists and evaluation tools to assist employers with the evaluation of their programs. Employers who want to take advantage of the ''grandfather'' provisions should be required to use a checklist based on objective criteria to demonstrate that their program is effectively reducing exposures to ergonomic risk factors, reducing the incidence and severity of musculoskeletal disorders, and complies with the standard's basic obligations. These materials are currently used by many ergonomics programs and could be made available by OSHA through its website (Ex. 500–207).

OSHA believes that the grandfather clause in the final standard is clear. For example, the training element requires the training of managers, supervisors, and employees in: (1) The employer's ergonomics program and their role in it; (2) the recognition of MSD signs and symptoms; (3) the importance of early reporting; (4) the identification of MSD risk factors and methods that may be used to abate them; and (5) the risk factors in problem jobs in the workplace and methods of controlling them. To provide employers flexibility, the standard does not address the details of how that training is provided, but it is clear about the topics the training must cover.

Other elements provide clear direction about how an employer is to demonstrate compliance. For example, the employer must evaluate the program, as demonstrated by regular reviews of the elements of the program, the effectiveness of the program as a whole, and the correction of identified deficiencies. Again, this language provides clear criteria that employers' evaluations must meet in order to be grandfathered in.

There are two aspects to Mr. Morikawa's comments (Ex. 30–4467) about the acceptability for grandfather clause status of programs meeting the California standard's two-incident trigger. The first relates to Federal OSHA's acceptance of the California ergonomics rule under the Act's provisions for ensuring that state standards developed by the State Plan States are as effective as the Federal standard. OSHA will, after it promulgates this final ergonomics program standard, evaluate the ergonomic standards developed by State Plan States (such as California and Washington) to determine whether they are ''as effective as'' the Federal standard. OSHA clearly could not have made such a determination at the time of the proposal, as Mr. Morikawa suggests, because the form and content of the final OSHA rule could not be known at that time. However, OSHA is unlikely to find any standard that delays protection to employees, including those in small firms, or that provides less protection to employees overall, as effective as the final rule.

The second relates to the details of grandfathered programs. Paragraph (c) of the final rule does not attempt to dictate precisely what form a grandfathered program must have, beyond stating that it must have the core elements of successful programs, be demonstrably effective, and be evaluated and in place by the final rule's effective date. OSHA has not mandated such program specifics because grandfathered programs will take many different forms, be at many different stages of development, and be taking various approaches to achieving success. The grandfather clause thus insists on the fundamentals but leaves the specifics to employers.

The final standard also requires the employer to demonstrate that an existing program is effective before that program qualifies under the grandfather clause (see paragraph (c)(1)(v)). The employer is free to use one of the measures specified in the standard itself (that is, reductions in the number or severity of MSDs, increases in the number of jobs in which ergonomic hazards have been controlled, reductions in the number of jobs posing MSD hazards to employees) or any other valid measure that the employer chooses to evaluate the program and demonstrate effectiveness. The Agency currently provides some compliance assistance materials that include ways to measure the effectiveness of ergonomic interventions. For example, the ''Ergonomic Program Management Guidelines for Meatpacking Plants'' (Ex. 2–13) provides a method for monitoring trends in cumulative trauma disorders that may be used for this purpose. OSHA's 1989 Voluntary Safety and Health Program Management Guidelines (Ex. 2–12) also describe effective program evaluations. These documents are available on OSHA's Website (http://www.osha.gov). OSHA also intends, as resources permit, to provide additional compliance assistance materials that will help employers determine whether or not their programs are effectively addressing MSDs.

In sum, OSHA believes that the final grandfather clause provides sufficient information for employers to determine if their programs qualify for the grandfather clause. OSHA compliance officers also will be able to assess whether the employer's program qualifies for grandfather status. OSHA will include directions on how this is to be done in a compliance directive to be issued soon after promulgation of the final rule.

5. Alternatives and Revisions to the Grandfather Clause

Several rulemaking participants suggested approaches that would permit alternative programs developed after the standard is in effect to be followed by employers in lieu of compliance with the standard (see, *e.g.,* Exs. 30–2216, 30–3765; 30–3813, 32–339, 500–44; Tr. 3477). Many of these commenters argued that their recommendations would address the previously discussed concerns with the proposed rule's grandfather clause—concerns such as the perceived illusory nature, vagueness, and subjectivity of the proposed grandfather clause. The alternatives or revisions to the proposed grandfather clause suggested by these commenters included:

- Revising the clause to allow programs that are incomplete at the time of the effective date to be grandfathered (see, *e.g.,* Ex. 30–3813; Tr. 4111);
- Revising the clause to make clear that a company whose program had been grandfathered could extend that program (and grandfather status) to establishments newly built or owned, or acquired through mergers or acquisitions (see, *e.g.,* Exs. 30–3813, 30–3922, 32–78; Tr. 5538);
- Revising the clause to allow any program developed by an employer at any time, including after the standard has become effective, to be implemented without fear of citation for noncompliance with the OSHA standard (see, *e.g.,* 30–429, 30–1090; Tr. 15657);
- Revising the clause to specify that OSHA will certify or approve employers' programs as qualified for grandfather status (see, *e.g.,* Ex. 32–133, 500–139);
- Revising the clause to recognize for grandfather status any program that complies with either the Washington State or the California standard (see, *e.g.,* Exs. 30–429, 30–434, 30–973, 30–1090, 30–1547, 30–1671, 30–2835, 30–3813, 30–4134, 31–337, 32–311);
- Delete the grandfather clause and substitute instead provisions giving employers credit for already having performed some of the required elements, such as training, before the effective date (see, *e.g.,* Exs. 30–1547, 32–185, 32–311, 32–339, 32–461, 500–207; Tr. 6423, 11129, 13092).

For example, ORC made several suggestions along these lines (Ex. 30–3813; Tr. 4111). First, they recommended that OSHA rename this section ''Alternative Programs Provision.'' They also suggested that, as a stimulus to innovation, OSHA allow employers who do not now have fully developed programs to qualify for grandfather status in the future when they do have such programs. DuPont SHE Excellence Center made a similar recommendation:

> [One] improvement in the flexibility would be to allow whichever elements that have been put in place to be grandfathered and those which are not in place to be added. The grandfather clause should not be an ''all-or-nothing'' clause (Ex. 30–2134).

In addition, ORC, along with other rulemaking participants, recommended allowing an employer's program to be grandfathered after the effective date of the standard, which would permit employers involved in mergers and acquisitions to put their already grandfathered programs into place in new establishments (see, *e.g.,* Exs. 30–3813, 30–3922, 32–78; Tr. 5538). ORC also recommended that OSHA permit employers to extend existing grandfathered programs to new establishments operated by the same employer (Ex. 500–214).

The rulemaking participants who recommended that the standard permit future alternative ergonomics programs to be grandfathered did not address how an employer might avoid noncompliance while developing the program or in the period before the employer had demonstrated the effectiveness of the new program. OSHA does not believe that such an approach would be workable. First, it would be administratively difficult (if not impossible) to enforce. Second, OSHA is issuing a final standard addressing ergonomic injuries because the varied approaches and often isolated interventions that many employers have adopted have not effectively addressed the problem, and a uniform and comprehensive approach to this most serious of occupational safety and health issues is clearly necessary. The approach recommended by the commenters would mean that, while employers try different programmatic approaches, employees would continue to be exposed to ergonomic hazards with no guarantee that the employers would ever qualify for ''grandfather'' status. Third, OSHA is loathe to require the expenditure of resources to make existing, effective programs containing all the core elements meet all the requirements being imposed by the full ergonomics standard. Employers without programs and employers with ineffective programs or programs missing key elements would need to expend resources to meet whatever requirements OSHA imposed on alternative programs. The Agency believes that these resources should be expended to meet the final standard in all its details so as to ensure adequate protection for employees.

OSHA agrees, however, that a company that meets the rigorous standards of paragraph (c) and thus qualifies for grandfather status should be permitted to apply the same excellent program that was grandfathered to new plants it builds or acquires by merger or acquisition. OSHA believes that permitting a grandfathered program to be extended in this way makes sense from two perspectives: first, it ensures that the new establishments will benefit from the expertise in ergonomics programs that the parent company brings, and, second, it ensures that the company will have a single, cohesive corporate ergonomics program. For these reasons, OSHA has decided to extend grandfather status to the programs implemented in newly acquired or built plants of a corporation that already has a grandfathered program.

The American Industrial Hygiene Association (Ex. 32–133) recommended that employers formally request OSHA to recognize their programs:

> As the standard puts much of the burden on employers to adapt the program to their own needs, it would be appropriate for OSHA to say that employers can ask to have their program ''grandfathered''. This would require them to formally document their program and compare it with the OSHA requirements. This should not be a problem if the company has a functional program (Ex. 32–133).

Kaiser Permanente made the same recommendation in their post-hearing comments (Ex. 500–139).

However, OSHA's resources do not permit it to evaluate employers' programs for grandfather status; in addition, a ''paper'' review of a program is not adequate to determine how it is working in practice. OSHA continues to believe that employers are in the best position to determine whether their programs qualify for grandfather status.

The Eastman Kodak Company (Exs. 30–429, 30–1090) suggested that the Agency adopt a flexible grandfather clause that recognizes good faith on the part of employers:

> We believe that what OSHA needs is a ''good faith'' grandfather clause that recognizes employers for a positive effort and ongoing solutions. We believe that it should be sufficient for an employer to have a written active program and show intent, to be compliant. The existing program rule (WAC 296–62–05110) of the Washington State proposed standard is better suited to this end and is recommended for incorporation (Ex. 30–429).

Other rulemaking participants also recommended that OSHA adopt the proposed Washington State approach towards existing programs (see, *e.g.,* Exs. 30–434, 30–2835, 30–3813, 30–4134, 31–337, 32–311). They argued that Washington's approach, which accepts alternative programs when the employer can demonstrate that the alternate methods taken as a whole are as effective as the requirements of the standard, would grandfather far more effective programs than OSHA's proposal. They also noted that this approach would focus the Agency's efforts on results rather than on details they perceived as minor.

The Washington State standard's grandfather clause reads as follows:

WAC 296–62–05110 When Do Employers' Existing Ergonomics Activities Comply With This Rule?

Employers may continue to use effective alternative methods established before this rule's adoption date. If used, the employer must be able to demonstrate that the alternative methods, taken as a whole, are as effective as the requirements of this rule in reducing the WMSD hazards of each job and providing for employee education, training and participation (Ex. 500–71).

Other commenters (see, *e.g.,* Ex. 30–4467) urged OSHA to accept compliance with the California ergonomics standard as constituting acceptance under the grandfather clause.

Again, as discussed above, formal recognition of the ''as effective as'' status of these two State-plan State standards must await a formal determination by Federal OSHA. However, since acceptance under the final rule's grandfather clause depends on program effectiveness, confirmation of that effectiveness through evaluation, and the inclusion in the program of the core elements, many proactive California and Washington employers' programs are likely to meet the final standard's requirements for grandfather status. The programs of many employers in these states may not meet these requirements, however, since neither State standard requires all of the core elements.

The AFL–CIO, the International Brotherhood of Teamsters, and others suggested that OSHA give employers credit for steps, such as training and job hazard analysis, they have taken toward controlling ergonomic hazards or for controlling hazards in problem jobs in their workplaces (see, *e.g.,* Exs. 30–1547, 32–185, 32–311, 32–339, 32–461, 500–207; Tr. 6423, Tr. 11129, Tr. 13092). These commenters believed that such credit could substitute for a true grandfather clause.

The final ergonomics standard does give credit to employers who have already carried out certain procedures or voluntarily complied with portions of the standard. For example, employers who have already performed job hazard analysis in some jobs would not have to re-analyze those jobs (see paragraph (j)(1) of the final rule). Likewise, employers who have already trained their employees in the ergonomic control measures they instituted would not have to duplicate that training (see paragraph (t)(5) of the final rule).

Some rulemaking participants suggested that OSHA recognize for grandfather status any ergonomics program in effect at the time the final rule becomes effective (see, *e.g.,* Exs. 30–494, 30–2989, 30–3781, 500–213; Tr. 10089). These commenters believe that these employers should be rewarded for their proactive stance toward ergonomics. For example, the National Council of Agricultural Employers said, ''a grandfather clause should recognize and exempt forward-thinking employers that have already implemented an ergonomics program'' [Ex. 30–3781]. The National Association of Convenience Stores went further to suggest that OSHA also grandfather trade-association-provided programs: ''OSHA [should] consider grandfathering existing risk management programs or industry-specific programs which trade associations may be able to provide to their members' (Tr. 10089). The Air Conditioning Contractors of America recommended that OSHA recognize virtually any existing ergonomics program under the grandfather clause (Ex. 500–53). It said that OSHA could require grandfathered programs to be improved at such time in the future as MSD hazards became better understood.

As explained earlier, OSHA believes that it is essential for grandfathered ergonomics programs to include all of the core elements of successful ergonomics programs and to meet demonstrable effectiveness criteria. OSHA agrees that employers who have already adopted existing programs are proactive; however, some of these employers are likely to have programs that are not as protective as the program OSHA is requiring or programs that do not include those elements shown to be essential to program effectiveness. It would therefore be inappropriate for OSHA to grandfather these programs.

Several hearing participants provided OSHA with alternative regulatory language for the grandfather clause in their post-hearing submissions (Exs. 500–44, 500–78, 500–80). Southwestern Bell recommended the following language (Ex. 500–78):

How does this standard apply if I already have an ergonomics program?

If you already have an ergonomics program for the jobs this standard covers, you may continue that program provided:

(a) You have a written program that contains:

(i) Defined roles and responsibilities;

(ii) Training on the prevention of work-related MSD's; and

(iii) Procedures for completing job hazard analysis for work-related MSD's.

(b) The controls implemented are intended to reduce or eliminate risk factors for work-related MSD's;

(c) You have a program evaluation process; and you have implemented your program before the effective date of the final rule (Ex. 500–78).

OSHA has considered Southwestern Bell's suggested language but has rejected it because the programs that would be grandfathered in by such language would be missing several important elements—employee participation, hazard information and reporting, and MSD management, for example. As explained earlier, OSHA considers these elements essential to any successful ergonomics program. In addition, Southwestern Bell's approach does not contain any requirement that the program be effective, be achieving positive results, or be reducing the number of MSDs.

The American Petroleum Institute (API) proposed language that would accept an employer's existing program if it contained the following seven elements: (1) Management leadership and employee participation, (2) hazard information and reporting, (3) job hazard analysis and control, (4) training, (5) MSD management, (6) program evaluation, and (7) recordkeeping (Ex. 500–80). API's proposal also would require grandfathered programs to contain subelements under each element. For example, under job hazard analysis and control, API's language included the following provisions: ''Jobs in the workplace must be assessed to identify the potential for MSD hazards. Consistent with the job assessment, an action plan is developed to control identified or potential MSD hazards determined to present a significant risk.'' Their language also suggested that grandfathered programs demonstrate effectiveness via measures such as the following: Decreases in the frequency of reported MSDs, decreases in the severity of MSDs, reduced workers' compensation claims related to MSDs, symptoms surveys, and a reduction of MSD risk factors. API did not include work restriction protection among the elements grandfathered programs must have.

API's suggested grandfather clause had two other features. First, it specifically recognized any program meeting the requirements of an employer's State OSHA ergonomics standard. Second, it recognized existing programs in both existing workplaces and newly acquired or built plants of a corporation that has a grandfathered program (Ex. 500–80).

API's approach is similar to the one OSHA is taking in the final standard's grandfather clause. The final standard includes all of API's recommended elements, and also requires the employer to demonstrate that the ergonomics program is effective. API's suggested criteria for determining effectiveness are also similar to those listed as examples in the final standard. Further, the final rule permits employers with grandfathered programs to extend those programs to new corporate plants.

On the other hand, OSHA is not, as discussed above, automatically grandfathering in employers' programs that comply with State-plan State ergonomics programs. In addition, API's suggested regulatory text would not require employers to provide WRP to employees who suffer work-related MSDs. As discussed earlier, OSHA has concluded that WRP is an essential part of any ergonomics program whether it is grandfathered or not.

The Dow Chemical Company also provided alternative language for a grandfather clause (Ex. 500–44). Their alternative provided criteria for seven core elements that ergonomics programs would have to meet to be grandfathered: hazard communication, MSD reporting, hazard identification, hazard evaluation and prioritization, risk mitigation or control, appropriate knowledge and skills (that is, training), and program evaluation. Dow included specific criteria for each of these elements and an explanation of how the criteria could be met for each of the elements. Dow likened their proposal to OSHA's Process Safety Management Standard (§ 1910.119), which sets the basic elements of a process safety management program and requires the employer to spell out the details.

However, OSHA is not adopting Dow's alternative grandfather clause approach in the final rule, for several reasons. First, Dow's language does not address several elements of ergonomics programs that OSHA considers essential, including management leadership, employee participation, and MSD management. Second, Dow's alternative is overly detailed. For example, the hazard communication element incorporates separate provisions on general information regarding MSDs and general information on warning signs associated with MSDs. It also includes a provision for providing specific information on potential ergonomic hazards in an employee's work area. Third, Dow's suggested grandfather clause appears to be designed to tightly match the company's own program rather than to fit a more widely recognized model ergonomics program, such as that in OSHA's meatpacking guidelines, a program lauded by many rulemaking participants who had experience with ergonomics programs (see, *e.g.,* Exs. 30–1294, 30–2216, 30–3046, 30–3677, 32–185; Tr. 14713). OSHA believes that more employers with effective existing programs will be able to qualify under OSHA's final grandfather clause, which is modeled after the Meatpacking Guidelines program, than those required by Dow's alternative.

Dow also commented on the enforcement implications of a performance-based grandfather clause:

> The verification of compliance to a performance language regulation is most effectively achieved when the method used for prescriptive regulation compliance verification is modified. The method used by Compliance Officers for a prescriptive regulation is based on the Officer's knowledge of what is specified by the regulation to be the practice, *i.e.* guard rail specification. However, for performance language regulations, such as the Process Safety Management regulation and the language suggested by Dow for this proposed regulation. The Compliance Officer only knows what elements are to be addressed by an employer's program: They will not know what to expect for practices. The means to address those elements are left to the employer so that they can use whatever means best match their workplace needs and the local culture. The Compliance Officer can only gain an understanding of that workplace program from the employer. This, we believe, is where the modification in approach should occur (Ex. 500–44).

OSHA believes that, like a true performance standard, the final grandfather clause is not prescriptive in nature and leaves the details of compliance to employers to determine. OSHA compliance personnel will look first to the employer's demonstration that the program includes the core elements and subelements and second that the program is effectively addressing MSDs. Compliance officers also may assess whether the employer's program in practice matches the written program that the employer has developed.

Magnus Farley, Inc., did not provide alternative language for the grandfather clause; however, they did recommend that OSHA develop revised language and publish it for comment before adopting a final rule (Ex. 500–102). They argued that this would give industry time to evaluate the new provision and respond to it. OSHA finds a re-proposal unnecessary, because participants had ample opportunity to provide comments on the proposed grandfathered clause. The sheer volume of comments received on this topic provides evidence of this fact. Further the final rule's grandfather clause is a logical outgrowth of the proposal. In fact, the final rule responds to the overwhelming public comment that OSHA should focus on effectiveness and recognize existing programs that do not look exactly like the one required by the rule.

Some rulemaking participants supported the proposal's approach toward existing programs with only minor modification (see, *e.g.,* Exs. 30–973, 30–1547, 30–2387, 30–3748, 32–85, 32–111, 32–339, 500–207; Tr. 15893). For example, the American Association of Occupational Health Nurses supported the proposed grandfather clause, but recommended that OSHA provide guidance for employers to use in evaluating their programs (Ex. 30–2387). The American Nurses Association supported the proposed requirement that existing program meet the basic obligation of each of the core elements of an ergonomics program (Ex. 30–3686). They did, however, recommend allowing employers up to 6 months to modify their programs so that they meet these basic obligations.

As noted earlier, program evaluation guidance is already available from the Agency. In addition, OSHA will be providing additional compliance assistance materials in the period following publication of the final rule. These materials will help employers judge whether their programs are effective and whether they qualify for grandfather status.

The final grandfather clause essentially accommodates the American Nursing Association's suggestion. Employers who, through one of the measures given in paragraph (c)(1)(v), can demonstrate that their programs are effective are free to add features that will bring them into compliance with the criteria given in paragraph (c)(1) any time before the effective date of the final standard. In addition, employers are given an extra 12 months to incorporate work restriction protection into their programs.

The Eastman Kodak Company argued that the proposal's grandfather clause would have required employers to fix all problem jobs before their programs were recognized (Exs. 30–429, 30–1090). The Boeing Company also noted that employers may have an acceptable program that covers some, but not all, of the jobs covered by the standard (Exs. 30–973, 30–1547). Boeing suggested allowing employers up to 2 years after the effective date to cover all such jobs.

As noted earlier, the final grandfather clause would permit employers to extend an ergonomics program that was successful in addressing some problem jobs to all problem jobs. In addition, because the final rule's compliance endpoints do not contain a set compliance deadline, employers may prioritize jobs for analysis and control if all jobs could not be controlled by the final rule's effective date.[6] Thus, the final standard addresses the concerns of these two rulemaking participants.

Some rulemaking participants suggested making the grandfather provisions more comprehensive (see, *e.g.,* Exs. 32–182, 32–198, 32–210, 32–339, 32–461). First, as noted earlier, the AFL–CIO and others recommended strengthening the basic obligations for four of the six core elements (see, *e.g.,* Exs. 32–198, 32–210, 32–339). Second, some participants urged OSHA to develop and publish checklists and evaluation tools to assist employers with the evaluation of their programs (see, *e.g.,* Exs. 32–85, 32–210, 32–339). Without these tools, they argued, an employer's program could be grandfathered without any solid demonstration that it is effective. The AFL–CIO argued that the standard should be as protective as, and consistent with, existing effective ergonomics programs, OSHA general duty clause settlement agreements, and OSHA and NIOSH recommended practice (Ex. 32–339). In keeping with this goal, they developed principles that they believe should guide OSHA in casting the final standard:

> The standard should codify and reflect the good industry practices and programs implemented by employers who have effectively addressed ergonomic hazards. It should build on the agency's enforcement actions and settlement agreements on ergonomic hazards under the general duty clause. The standard also should be consistent with the measures used in other agency standards on toxic substances and physical agents such as the lead and formaldehyde standards and those which follow a programmatic approach, such as the Process Safety Management and Hazard Communication Standards (Ex. 32–339).

OSHA believes that the final rule's grandfather clause is comprehensive enough to ensure that inadequate programs do not qualify and is flexible enough to permit many different kinds of effective programs to qualify. As explained previously, the Agency believes that requiring programs to meet a combination of essential program elements and recognized effectiveness measures will prevent inadequate ergonomics programs from achieving grandfather status. On the other hand, OSHA does not agree that it is necessary to codify the precise practices used in the most effective programs, as the AFL–CIO suggests. Doing so would unnecessarily limit an employer's flexibility in complying with the final standard. The Agency believes that the final rule has achieved a balance between flexibility and comprehensiveness that will recognize effective ergonomics programs and deny grandfather status to inadequate ones.

6. Other Comments on the Proposed Grandfather Clause

The National Soft Drink Association objected to the requirement that the employer's program be evaluated and found to be functioning properly before the effective date of the standard (Ex. 30–3368). The trade association argued that a thorough evaluation of any program will probably uncover areas that could be improved. Other rulemaking participants also recommended that the standard allow employers to modify their programs so that they could be improved (see, *e.g.,* Exs. 30–1547, 30–3765, 30–4130, 30–4537). For example, the Boeing Company was concerned that an employer would not be able to improve an existing program without falling out of compliance with the grandfather clause (Ex. 30–1547). In response, OSHA recognizes that all ergonomics programs will need to be modified over time to correct deficiencies. The standard not only accommodates this, but requires it in paragraph (c)(1)(v).

Some commenters stated that the proposed grandfather clause would force existing programs to include the six core elements if they wished to be grandfathered even if the employer did not have an employee with an MSD that triggered the standard (see, *e.g.,* Exs. 30–715, 30–3678). In response, OSHA considers it most unlikely that an employer with an effective existing program would not have employees experiencing MSDs.

Some rulemaking participants suggested that OSHA strengthen the grandfather clause in various ways (see, *e.g.,* Exs. 30–2039, 30–4538, 32–182, 32–185). For example, the American Federation of Government Employees recommended that employers have a documented program in place for at least 2 years before being eligible and that a grandfathered program be required to comply with the full standard if any MSDs occur (Ex. 30–4538). They also urged OSHA to require that, in evaluating the program, the employer determine that it is effective in addition to functioning properly. The American Federation of State, County, and Municipal Employees recommended that OSHA require that all elements of an employer's ergonomic program be effective before the employer is eligible under the grandfather clause (Ex. 32–182). Mr. Howard Egerman was concerned that having the employer evaluate its own program was bound to be ineffective because the employer could not be disinterested (Ex. 30–115). Communication Workers of America Local 2222 recommended that the standard require employees to agree with the employer's evaluation before an existing program would be acceptable and that OSHA mediate any disputes (Ex. 30–2039).

OSHA believes that the grandfather clause in the final rule will be protective of employees' safety and health without the addition of these suggestions. The Agency is therefore not setting a minimum time period that an employer's program must have been in place to be judged effective to qualify for the grandfather clause. The final grandfather clause requires the employer to be able to demonstrate that the program is effective and to evaluate its elements and correct any deficiencies identified before the effective date.[7] This will ensure that only relatively mature programs qualify for grandfathering.

Many rulemaking participants testified that MSDs still occur in workplaceswith the best ergonomics programs in place (Exs. 30–3765; 30–4046; Tr. 14730). OSHA agrees that this is often the case, and the final rule specifically notes that the occurrence of MSDs does not constitute a violation of

[6] Even though the final rule's grandfather clause does not contain a fixed deadline for implementing controls for a problem job, an employer with a grandfathered program is expected to institute permanent controls as soon as possible. An employer who postponed the control of MSD hazards beyond a reasonable amount of time would have difficulty demonstrating the effectiveness of the program.

[7] However, as explained earlier, the final grandfather clause does permit an employer to incorporate work restriction protection in the ergonomics program within 12 months of the effective date.

the standard (see the note to paragraph (k)).

Although the employer will be evaluating the program, OSHA believes that Mr. Egerman's concern is unfounded, because paragraph (c)(1)(v) requires the employer to be able to demonstrate that the program is effective. This provision, and the inclusion of the core elements, should ensure that the evaluation is appropriate. In addition, the final grandfather clause requires qualifying programs to include employee participation in program evaluation. This will also act as a check on the accuracy of the evaluation process. For these reasons, the Agency believes that the grandfather clause in the final ergonomics standard will provide an appropriate level of protection for employees.

Some rulemaking participants objected to language in the proposal that required the employer to show that their program complies with the basic obligations and is functioning properly (see, *e.g.,* Exs. 30–541, 30–562, 30–1355, 30–1547, 30–3117, 30–3783, 30–4607). They argued that the burden should be on OSHA's compliance staff to address ergonomic hazards rather than on the employer to demonstrate that its program qualifies. Some of these rulemaking participants argued that placing the burden on employers to demonstrate program effectiveness would disproportionately affect small employers, who do not have the resources of larger ones (see, *e.g.,* Exs. 30–3117, 30–3783). Caterpillar, Inc. stated that the subjective nature of the grandfather clause would lead to uneven enforcement across employer groups and across the nation (Ex. 30–4607).

The American Apparel Manufacturers Association also was concerned about enforcement and gave the following example of how an employer's interpretation of what constitutes a problem job could differ from that of an OSHA compliance officer:

> An apparel manufacturer may see two sewing jobs as extremely different, involving different activities and physical requirements, but an OSHA inspector with no experience in the apparel industry may well see them as the same. This ambiguity of language may cause penalties against companies who believed they were, in good faith, running a successful ergonomics program (Ex. 30–4470).

The Boeing Company was also concerned about being second guessed by OSHA enforcement personnel (Exs. 30–973, 30–1547). They recommended that the standard unambiguously recognize programs addressing the basic obligations. In particular, Boeing urged OSHA to clarify that an employer who is complying with a written program that meets the grandfather clause is in compliance with the standard (Ex. 30–1547). They argued as follows:

> Where employers are already undertaking what can reasonably be done in good faith to minimize problem jobs, they should be protected from second-guessing by inspectors. OSHA's limited resources are better used focusing on worksites where ergonomic hazards have yet to be addressed, not on worksites which have already implemented effective ergonomics programs (Ex. 30–1547).

Others believed that it is appropriate for OSHA to require employers to demonstrate the effectiveness of their programs (see, *e.g.,* Exs. 30–429, 30–2835, 30–3813, 30–4134, 31–337, 500–214). These commenters argued that this was the approach taken by Washington State in its ergonomics standard, and they believed that it was reasonable.

OSHA finds, based on a review of the evidence in the record as a whole, that the final grandfather clause is not likely to lead to uneven enforcement. It is true that employers will need some method of assuring themselves that their ergonomics program qualifies for the grandfather clause, and the method chosen also will be useful to OSHA compliance personnel. However, OSHA will not cite employers who make an adequate demonstration [8] that their programs are effective and include the elements and subelements in paragraph (c)(1). However, if the Agency finds objective evidence that the employer is basing the demonstration on inaccurate information, OSHA will not consider that employer's program as qualifying for grandfather status.

OSHA also believes that it is reasonable and appropriate to place the burden of demonstrating that their programs qualify for grandfather status on employers because grandfathered programs are the ''exception'' to the standard. Employers who choose to take advantage of using a program that is not required to meet the full ergonomics standard in all its details can reasonably be expected to produce evidence that their programs qualify for the grandfather clause. OSHA needs assurance that employees in workplaces with grandfathered programs will be adequately protected by these programs. For these reasons, the final grandfather clause requires the employer to demonstrate that their programs qualify for grandfather status.

[8] An adequate demonstration is one that touches on all subelements spelled out in paragraph (c)(1) and that shows effectiveness using an appropriate measure of effectiveness.

Some rulemaking participants complained that the proposal would require employers wanting to take advantage of the grandfather provision to keep unnecessary records (see, *e.g.,* Exs. 30–2645, 30–2815, 30–2835, 30–4628). For example, the Chemical Manufacturers Association and others stated that an unwarranted paperwork burden would be forced on an employer because it would have to document that the program met the basic obligations and that the program is functioning properly (see, *e.g.,* Exs. 30–2835, 30–3356, 30–4628).

The final grandfather clause does not require the employer to maintain any records. In fact, the final standard does not require employers whose programs are grandfathered to maintain any of the records required by the full standard in paragraph (v). Some employers may choose to maintain certain records to facilitate their demonstration of effectiveness. However, some effectiveness measures require no records. For example, the Dow Chemical Company, whose program involves the evaluation of all tasks in high risk jobs and control of all ergonomic hazards in those jobs, would need only show that adequate controls are in place to demonstrate effectiveness. (They also would need to show that their program includes the elements and subelements given in paragraph (c)(1).) In addition, most employers with existing programs are already required, under 29 CFR Part 1904, to maintain injury and illness records. Employers should be able to use those records, with little or no modification, to demonstrate effectiveness. Thus, OSHA has concluded that comments that the grandfather clause would create an unwarranted paperwork burden are unfounded.

Some rulemaking participants argued that companies would be forced to alter their existing safety and health programs to meet the OSHA ergonomics standard, forcing them to inefficiently allocate resources away from their safety and health programs (see, *e.g.,* Exs. 30–2216, 30–3845, 30–4818, 31–310; Tr. 11379, 11403). These commenters apparently believe that two separate and incompatible programs would be required or that grandfathering would require major restructuring of their current ergonomics program. For example, the Forum for a Responsible Ergonomics Standard recommended that OSHA recognize existing programs that met the goal of reducing or eliminating MSD hazards regardless of whether or not they met the technical specifications of the six proposed program elements (Ex. 30–3845).

Otherwise, they argued, the standard would not only upset the performance of existing programs but would result in poor allocation of risk control resources. They gave examples of what they believed might occur:

[O]ne Forum member, CCE, has spent millions of dollars researching and developing methods to reduce injuries related to various warehousing and delivery activities, such as improving new order fulfillment systems. In this respect, CCE is pioneering achievements that likely will eventually be adopted throughout its industry. However, particularly with respect to employee participation in developing safety programs, CCE is unlikely to meet the strict requirements for grandfathering. As a result, CCE anticipates that many of its current efforts will be derailed as resources, especially the time of its highly trained staff, will have to be diverted to ensuring compliance with the OSHA standard. Instead of developing fixes that will prevent injuries, these resources will be directed towards ''fixing'' the administrative structure of its program.

Similarly, many NACS members (convenience store operators and petroleum marketers) incorporate MSD prevention and ergonomics issues into their general worker safety programs that cover a wide range of issues, from dealing with slips and falls to robbery deterrents to customer safety issues. These programs have been extremely effective in reducing MSD injuries. If not grandfathered, implementing OSHA's proposed standard would require upsetting and dramatically changing these already effective programs (Ex. 30–3845).

Mead Corporation (Ex. 30–2216) made a similar comment:

Responsible employers would be forced to alter achieving programs and pursue measures that we know are not as effective as what we are already doing. The resources that are focused on MSD prevention would be shifted toward less meaningful activities. A new infusion of MSDs may result at many workplaces that have effectively controlled these types of accidents to date because of the shift in emphasis brought on by compliance demands.

Consider:

• Many companies utilize periodic risk assessments to update priorities for ergonomics projects. Risk assessments commonly include a survey of the workplace, discussions with employees about potential concerns, and analysis of MSDs. Priorities are established and incorporated into a work plan for the site's ergonomics/safety team.

• When ergonomics teams in Mead conduct analyses of jobs, they are encouraged to identify as many opportunities for continuous improvement (potential risk factors) as possible and then to prioritize based upon risk. Action plans are developed for high risk concerns. Lower priorities are not addressed at the time unless they are low cost. Teams maintain documentation of these items and may revisit them in the future once higher priority items are resolved

In each of these examples, employers are pursuing activities that should be recognized as meaningful and exceeding the level of protection OSHA is currently seeking for the control of MSDs. With the proposed standard, however:

• When persistent symptoms develop at a job considered to be moderate priority for continuous improvement, higher priority changes would be delayed, placing more employees at higher risk for developing MSDs;

• Similarly, when partial work aggravation associated with a low risk task triggers a manufacturing job, high priority changes recommended by the ergonomics team based upon comprehensive analysis will be delayed; and

• Documentation of MSD prevention activities will be increasingly scrutinized and restricted due to concerns over how OSHA would interpret the information (Ex. 30–2216).

On the other hand, the American Society of Safety Engineers stated that ergonomics programs fit easily into existing safety and health programs:

The establishment of basic ergonomic management programs, increasing employee awareness and involvement on these issues is not a burden to employers when compared to other safety and health compliance requirements.

In fact, most efficient and effective ergonomic initiatives will usually dovetail with other existing safety and health programs (Tr. 11611).

The final rule in general, and the grandfather clause in particular, will not, in OSHA's view, require an inefficient reallocation of resources. In fact, because MSDs are the leading cause of on-the-job injuries and illnesses, OSHA believes that the final rule will ensure that resources will be devoted to areas where significant improvement in injury and illness rates can be realized.

OSHA agrees with the American Society of Safety Engineers that ergonomics programs fit well as part of comprehensive workplace safety and health programs. The final grandfather clause does not require employers to divorce ergonomics from their existing safety and health programs. Thus, employers who address ergonomics in existing effective safety and health programs typically will not need to reinvent their ergonomics program just to qualify for the grandfather clause.

In addition, as noted earlier, the final rule accommodates prioritization of the implementation of permanent controls, as Mead Corporation is doing, where the employer cannot fix all problem jobs at once. Therefore, OSHA does not believe that the final rule's grandfather clause will be disruptive or result in an unwarranted reallocation of resources.

Union Carbide recommended that the standard not require employee participation in the *development* of existing programs that would otherwise qualify under the grandfather clause (Ex. 30–3784). ORC also identified employee participation in the development of each element of the program as one area that few of its member companies could comply with (Tr. 4135).

OSHA agrees with these rulemaking participants that employee participation in the development of ergonomics programs is not necessary where an existing program that qualifies for the grandfather clause is at issue. The primary purpose of the grandfather clause is to recognize ergonomics programs that employers have already put into place, *i.e.,* that are already well past the developmental stage. According to ORC, some of these programs have not involved employees in the past development, implementation, or evaluation of the program. As drafted in the final rule, employee participation in these stages of program implementation is required as appropriate, from this time forward. In other words, OSHA is not requiring employee participation in the past development of a program as a condition of the grandfather clause; it is requiring employee participation in the implementation, evaluation, and future development of grandfathered programs, however.

Alcoa, Inc., recommended that, for existing capital-intensive industries and equipment, OSHA allow employers additional time to come into compliance with the grandfather clause (Ex. 30–3922). They argued that the implementation of permanent controls within 2 years, as proposed, was neither realistic nor economically feasible for some employers. The final rule's grandfather clause allows an employer to have a process for identifying, analyzing, and controlling MSD hazards in problem jobs and following up to ensure control effectiveness. Through a prioritization process, an employer may choose to temporarily implement interim controls. Although the employer is expected to institute permanent controls as soon as possible, the final rule does not provide a date when this must be accomplished. Thus, employers in all industries with qualifying programs will be able to prioritize their jobs for control in a rational manner that permits them to take advantage of the capital involvement and replacement schedules of their industries.

Paragraph (d)—What Information Must I Provide to my Employees?

Paragraph (d) of the final rule requires employers to provide their employees with basic information about five items:

(i) Common musculoskeletal disorders (MSDs) and their signs and symptoms;

(ii) The importance of reporting MSDs and their signs and symptoms early and the consequences of failing to report them early;

(iii) How to report MSDs and their signs and symptoms in the workplace;

(iv) The kinds of risk factors, jobs and work activities associated with MSD hazards; and

(v) A description of the requirements of OSHA's ergonomics program standard.

This information must be provided to new employees within 14 days of hiring, and must be posted conspicuously in the workplace. Consistent with applicable law, information may be posted or provided electronically to employees who have electronic access. To assist employers in meeting their obligation under this paragraph, OSHA has included nonmandatory Appendices A and B, which contain all the information needed to comply with this paragraph, except for the workplace-specific information on reporting MSDs and their signs and symptoms.

The proposed rule also would have required employers to provide employees with information on how to recognize MSDs (and their signs and symptoms); on the importance of early reporting of MSDs; and on how to report MSDs at their workplace. It also would have required employees to establish a reporting system for MSDs. These provisions in the proposed rule, however, would only have applied to manufacturing and manual handling employers. OSHA expected the provisions to serve three purposes: to facilitate employees' active participation in their employers' ergonomics programs; to promote early reporting so that MSDs could be treated most effectively; and to assure prompt identification of MSD hazards so that the incident trigger of the standard would work properly.

There was a great deal of support, in general, for requiring employers to provide hazard and reporting information to employees (see, *e.g.,* Exs. 30–2116, 30–3813, 30–3748, 30–3765, 30–3934, 32–339–1, 32–111–4, 32–185–3, 30–3686, 32–461, 32–210–2, 30–3826, 30–3686, 32–182–1, 30–2116, 30–3748, 30–4564, 32–198–2, 500–33, 32–21–1, 32–450–1, 30–4247 and 32–450–1). Mr. Mark Davidson, Risk Manager for Safeway Stores testified (Tr. 13674, 13658) that he adamantly supported pre-injury efforts to train and evaluate people. He stated the fact that Safeway had produced a video to educate employees on symptoms of soft tissue injury and had merely shown it to employees across the United States. Both Akers Logging (Tr. 12325) and Swift Company Timber Management (Tr. 12315–16) believed that this information could be incorporated into regular safety meetings, and Mr. Swift testified that the cost would be nominal, if anything.

In fact, a number of participants urged OSHA to go even further and require employers to survey their employees to identify existing signs and symptoms (see, *e.g.,* Exs. 31–113, 31–150, 30–4538, 31–243, 31–186, 30–2387, 31–156, 31–125, 31–105, 31–43, 31–23, and Tr. 4732–33). One commenter (Ex. 31–186) said that, as well as promoting the early detection of MSDs, thereby saving employers money and lost work time, surveys also send the message that the employer cares about employee health and safety. The American Association of Occupational Health Nurses (AAOHN) (Ex. 30–2387) also said that MSD symptoms surveys should be strongly encouraged, if not required.

Other commenters argued that the benefits of this information provision should not be limited to jobs involving manufacturing and materials handling (Ex. 30–3826). Since implementation of any ergonomics program outside manufacturing and manual handling would have been based on the occurrence of an OSHA-recordable MSD, it made little sense, these commenters felt, not to provide employees in other jobs with information on what and how to report:

> Employees cannot be expected to report early if they are not educated on what signs and symptoms of MSDs are and if the employer is not communicating with them the importance of reporting early. Also, if employees are not aware of, or do not know the mechanism of reporting, than it is surely less likely that they will report * * *. This will be a great disincentive for reporting (Ex. 32–210–2, pg. 130).

See also, *e.g.,* Exs. 500–126, 32–85–3, 30–4538, 32–198–4, 30–2387.

Some commenters, however, objected that employers should not be required to provide hazard and reporting information before an MSD occurred (see, *e.g.,* 30–3723, 30–3867, 30–3086, 30–4465, 30–4607, 30–1012). These commenters argued that providing the information would be an unjustified consumption of resources, infrastructure capacity, and support, adding overhead and cost with no potential benefit. The General Electric Company (Ex. 30–1071) felt that an employer proactively identifying ergonomic issues would likely unearth complaints of MSD signs and symptoms. The American Iron and Steel Institute (AISI) (Ex. 32–206–1) stated:

> The provisions in proposed Sections 1910.914 and 1910.916 requiring the employer * * * to inform workers of the signs and symptoms of MSDs and how to report them would create an enormous potential for abuse of the system. The manner in which OSHA is expected to enforce those provisions will only exacerbate the problem (Ex. 32–206–1, pg. 40).

Other participants also expressed concern that providing employees with additional information about MSDs will cause workers to misattribute benign symptoms to serious injury or disease, thereby heightening symptoms and distress, or otherwise to make false reports (Exs. 32–241–3–2, 30–3716, 30–3000, 30–4843, Tr.16087, Tr. 10445–6). Omni Services Incorporated (Ex. 30–4496–35) believes it would be easy for employees to report almost any ache or pain as work-related and get paid time off until they feel better.

The Painting and Decorating Contractors of America (Ex. 30–3716) voiced concern that the information presented to employees about MSD signs and symptoms and the importance of reporting them early would not only require employers to develop expertise in ergonomics-related injuries, but would encourage employees to classify almost any job-related ache or pain as an MSD. The Plastics Engineering Company (Ex. 30–2435) stated that the requirements would encourage employees to report both real and phoney or exaggerated MSDs. The American Road and Transportation Builders Association (Ex. 30–4676) argued that the number of work-related MSD claims, and the number determined to be work-related, would significantly increase. See also Exs. 500–127, 31–106, 31–344, 32–82–1, 30–3749, 30–3336, 30–3367. The AAOHN (Ex. 30–2387), however, pointed out that often, after ergonomic training, employers experience an increase in MSD complaints and should be prepared for this eventuality. As noted elsewhere in the Preamble, these are not ''new'' MSDs, but instead the expected earlier reporting of MSDs that are already occurring.

OSHA does not find evidence that encouraging early reporting of MSDs promotes abuse. Evidence discussed in other sections of this Preamble indicates that programs that encourage early reporting of MSDs, so that employees can enter an MSD management program, actually reduce the time employees are subject to work restrictions. OSHA also has analogous requirements in other standards, for example, the Bloodborne Pathogens standard (29 CFR 1910.1030) and several of its chemical exposure standards (Cadmium, 29 CFR 1910.1027; 1,3-Butadiene, 29 CFR 1910.1051; Methylene Chloride, 29 CFR 1910.1052), and has seen no evidence that the provisions are abused. These provisions simply require that the employer provide basic information to employees; have a system in place for employees to report possible injuries, illnesses, and exposures; and evaluate and respond to these reports. As is discussed more fully in connection with paragraphs (e) and (f), a report of an MSD does not impose any obligations on employers unless the employer determines that the MSD is work related and meets the severity criteria, and the job itself meets the levels of the Basic Screening Tool in Table 1.

OSHA also agrees with the comments discussed above urging that all general industry employees be provided with this information. It believes the incident trigger in the standard can only be fully effective if all employees have basic information about MSDs and how and why to report them promptly. This means that some general industry employers, who under the proposal would have had no obligations at all until receiving a report of an MSD, will now have to provide this information. OSHA emphasizes, however, the minimal nature of the burden imposed by this paragraph. All of the information, except that on how to report MSDs and signs and symptoms to a particular employer, is contained in Appendices A and B to this standard, and will also be posted on OSHA's website. Employers need only copy or download the information for distribution to their employees. This responds to a number of comments asking OSHA to provide materials to assist employers in providing information to employees (see, *e.g.,* Exs. 30–429, 30–4492, 30–2987, 30–3232, 30–3853, 32–337–1, 32–210–2, 32–461–1, 32–461–1, 30–3826, 30–4538, 30–3686, 30–2387).

The requirement that employees be given information on how to report MSDs and their signs and symptoms is also necessary to ensure the effectiveness of the standard's exposure trigger. This requirement is even more basic than that contained in the proposed rule. It does not require employers to set up any particular reporting system, only that employees know how to report their MSDs or signs and symptoms. Particularly for a very small employer, this could be as basic as telling them to report them to a supervisor or safety official. Larger employers may use their existing reporting systems (Ex. 30–3826). Although OSHA intended this option also to be available under the proposed rule, several commenters interpreted the proposal as requiring a reporting system specific to MSD signs and symptoms (Exs. 31–78, 30–240, 30–3723, 30–3765, 32–77–2, Tr. 5340, 30–3853, 32–337–1, 30–716, 30–2215, 500–127). In light of the revised language in the final standard, these comments are now moot.

Other commenters, however, urged OSHA to adopt a more elaborate MSD reporting system. The American Federation of Teachers (Ex. 32–326–1) urged OSHA to strengthen the reporting requirements by stipulating that employers document a method for encouraging employees to report. Morgan, Lewis, and Bockius (Ex. 30–4467) expressed concern that employers would have no sure way of knowing whether a reporting system would satisfy an OSHA compliance officer's interpretation of the standard's requirements. OSHA does not agree that more detail is necessary in this provision.

The final standard allows employers extensive flexibility to tailor reporting systems to the demands of individual workplaces. Variations among employers (*e.g.,* size, management structure, number and type of facilities) could lead to some types of reporting systems being more effective than others for different employers. Some may choose written reporting systems, while others may feel that an oral system is a ''better fit'' for their particular situation. OSHA demands only that, whatever approach is used, it must be accessible and carried out in an orderly way that is recognized and understood by the involved parties.

A few commenters questioned the requirement to provide employees with a summary of the standard (see, *e.g.,* Exs. 30–3765, 30–1336, 30–3782–12, 30–2836, 30–2940, 30–240). The G. Leblanc Corporation (Ex. 30–4837) stated that, with the exception of this item, the information to be provided to employees would be very helpful in making the reporting/response system successful. It also felt that inclusion of the summary resulted in additional cost and expertise necessary for providing the information. The Dow Chemical Company (Ex. 30–3765) also commented that, while it supports telling employees about MSD hazards, signs and symptoms, the importance of reporting them early, and the mechanics of how to report them and uses a program that emphasizes the information envisioned by this provision, it does not support providing a summary of the requirements of the standard. The Edison Electric Institute (Ex. 32–300–1) also objected to the requirement that supervisors and employees be trained in the requirements of the standard.

Some of these commenters (see, *e.g.,* Exs. 30–1336, 30–2836, 30–2940) voiced concern about not knowing how many pages of information were sufficient to comply with this requirement, while others (see, *e.g.,* Ex. 30–3782–12) felt that how to interpret a ''summary of the standard'' and how to provide this to the employee was left to the employer's imagination. These concerns are addressed by the inclusion of nonmandatory Appendix B to the standard.

On the other hand, several commenters stated that employees should receive even more information (Exs. 30–4538, 31–242, 32–461–1, 32–210–2, 32–182–1, 32–111–4, 32–339–1, 500–218, Tr. 3481–82, 500–126, 31–280, Tr. 4542–43). For example, the AFL–CIO recommended that the hazard information and training requirements be restructured to move some of the training requirements up-front and stated:

> Specifically, we recommend that the Hazard Information and Reporting section require information and awareness initial training on the following:
>
> 1. Common MSD hazards;
> 2. The signs and symptoms of MSDs and the importance of recognizing and reporting them early;
> 3. How to report MSDs, signs and symptoms of MSDs, and MSD hazards and the prohibition against discouraging employee reports;
> 4. An explanation of this standard, including ways for employees to participate and how to get a copy of the standard;
> 5. An explanation of MSD management, including temporary work restrictions and work restriction protection; and
> 6. The principles for controlling common MSD hazards. (Ex. 32–339–1, pgs. 32–33)

Other commenters suggested that additional topics such as employee rights to job protection, right to report reporting procedures, symptom reporting procedures and training be included (see, *e.g.,* Exs. 32–461–1, 30–4538, 30–3686, 32–198–4, 32–198–4–1, 32–198–4–13)

OSHA has considered these comments and incorporated some of the suggestions. Other topics are addressed in the context of ergonomics program training under paragraph (t). The information requirement in this paragraph (d), however, is intended to provide employees with the minimum amount of information they need to perform their function under the standard: recognizing and reporting MSDs and their signs and symptoms, and doing so as early as possible. Employers are free to provide additional information (*e.g.,* explaining their particular ergonomics program), but OSHA does not believe that more detailed information is necessary before any MSD hazards have been found. As previously discussed, the Agency has attached an information sheet for the employer to use in providing the required information.

Finally, the issue of the posting of this information was also raised by several commenters (see, *e.g.,* Exs. 31–70, 31–342, 30–240, 30–1726, 30–1104, Tr. 10586). One commenter (Ex. 31–70) stated that the final standard should require mandatory posting of information for employees. Similarly, another commenter (Ex. 31–342) commented that there should be a requirement to either post a notice that employees should report possible MSDs promptly or inform employees in another effective manner. The National Association of Orthopaedic Nurses (Ex. 30–1104, Tr. 10586) supported a readily identifiable posting of MSD signs and symptoms, who to report to, and how to report. In addition, the University of Wisconsin Extension (Ex. 30–1726) urged OSHA to develop ''more boilerplate'' on a policy that encourages reporting and to require that this policy be posted in the workplace. On the other hand, August Mack Environmental (Ex. 30–240) argued that posting was redundant, unnecessary and posed a problem due to often limited space available for postings. It felt that the currently required OSHA poster already contains information on how to get additional information about OSHA standards.

Paragraph (d)(2) of the final standard requires that the information provided to employees must also be posted in a conspicuous place. In addition to an employee bulletin board, such places may be the employee locker room, lunch room, or near the time clock. Electronic posting is also permissible where all employees have access. While the Agency realizes that these options are not available in all facilities, most employers have some area, recognized by employees, where the employer posts company announcements and information. OSHA believes the posting requirement is necessary because many employees may not have immediate access to their original information sheet when they are beginning to develop an MSD.

In conclusion, OSHA has considered all of the comments and testimony received on the proposed provisions requiring employers to provide hazard information and reporting. It has decided to retain the requirement that employers covered by the final rule to provide minimal information to employees before an MSD incident occurs. OSHA believes the final rule provision is adequate without requiring additional measures such as surveying employees to identify signs and symptoms of MSDs.

Paragraph (e)—When Must I Take Further Action?

A. Introduction

The final rule incorporates a two-stage action trigger. It requires further action when (1) an employee experiences a work-related MSD involving either one or more days away from work, one or more days of limitations on the work activities of the employee, medical treatment beyond first aid, or 7 days of persistent MSD signs or symptoms (2) in a job with exposures to risk factors that meet the Basic Screening Tool in Table 1. Unless both stages of this action trigger are reached, the standard does not require employers to take any action beyond providing the information in paragraph (d) to their employees.

The action trigger in this standard serves a purpose analogous to that served by action levels in OSHA standards regulating exposures to air contaminants. Those standards generally require that airborne levels of the contaminant be kept below a permissible exposure level (PEL). At a much lower level, however, employers are required to take actions such as conducting air monitoring and providing training and medical surveillance to exposed employees, although they do not actually need to implement controls to reduce exposures to the regulated substance. Similarly, in this standard, once a job meets the action trigger, the employer must implement an ergonomics program that includes job hazard analysis, training, and MSD management (for the injured employee), although it may not actually be necessary to control or reduce the MSD hazard.

This concept is similar to the approach OSHA took in the proposed rule. In the proposal, an employer was required to take further action if an OSHA-recordable MSD occurred in a job meeting certain ''screening criteria,'' *i.e.,* the job involved physical work activities and conditions that were reasonably likely to result in the MSD, and those activities were either a ''core element'' of the job or accounted for a ''significant amount'' of the employee's worktime. In manufacturing and manual handling jobs, an OSHA-recordable MSD was not necessary if an employee reported persistent symptoms and the employer had knowledge of problems in the job.

OSHA received a large number of comments about the proposal's triggering mechanism. These comments fell into several categories. Many parties objected that the single MSD incident trigger included in the proposal was either too sensitive or not protective enough. Others objected to the use of an OSHA-recordable MSD, often pointing out that OSHA has proposed to amend its recordkeeping regulation, and that those amendments could also affect this ergonomic standard. In addition, commenters complained that the proposed standard's screening criteria would be extremely difficult to apply in practice, pointing in particular to the terms ''core element,'' ''substantial part of the workday,'' and ''reasonably likely to result in the MSD.''

As explained below, OSHA has made a number of changes in response to these comments. The triggering mechanism in the final rule has more precisely defined elements, and OSHA believes it should be much easier to apply.

A job meets the action trigger in the final standard based on two criteria. The first is what has been called the ''single-incident trigger.'' Under this criterion, an employee working in the job must have incurred either a work-related MSD severe enough to result in a work restriction, medical treatment beyond first aid, or MSD signs or symptoms lasting at least 7 consecutive days after being reported to the employer. A work restriction is defined in the standard as one or more days away from work, one or more days of limitations on the work activities of the employee's current job, or one or more days of temporary transfer to alternative duty (see paragraph (z)). Under the final rule, an MSD meeting this description is an ''MSD incident.'' The employer's first duty, after receiving a report of an MSD or MSD signs or symptoms, is to determine whether the report constitutes an MSD incident.

The second step of the action trigger, which must only be addressed after an MSD incident occurs, is based on the employee's exposures to ergonomic risk factors. If the employee is exposed to one or more of the risk factors described in the Basic Screening Tool in Table 1 for longer than the time listed for that risk factor, then the job meets the screen.

B. MSD Incident Trigger

1. Incident-Based Approach

The proposed standard also included a single-incident trigger. Under the proposal, employers of workers engaged in manufacturing and manual handling would have been required to implement some elements of an ergonomics program standard soon after the standard took effect, whether or not MSDs had occurred in their jobs. Once a ''covered MSD'' meeting the screening criteria occurred, those employers would have been required to adopt a full ergonomics program. Other employers would not be required to take any action before a ''covered MSD'' meeting the screening criteria occurred, but once that happened, they also were required to adopt the full program. In this final rule, OSHA has clarified that the only action explicitly triggered by an MSD incident is to apply the Table 1 screen. OSHA finds that the record supports using an MSD incident for this purpose.

A number of participants objected to the proposal's incident trigger on the basis that it was reactive and appeared inconsistent with OSHA's mission ''to prevent the first injury'' (Ex. 500–218, Tr. 9071, 9156, 12277, 12477). A number of labor organizations favored a proactive approach because, according to the International Chemical Workers' Union, ''[w]aiting for a covered MSD or persistent MSD symptoms to arise, versus evaluation and prevention, is a lose-lose proposition'' (Ex. 32–198–4, 32–461–1, 500–137; see also Ex. 500–218, Tr. 12365, 17543). The Farm Workers Justice Fund urged OSHA to adopt a hazard-based approach because in many workplaces employees experience a great deal of pressure not to report injuries (Tr. 17515).

Some employers and representatives of employers also supported a hazard-based rather than an incident-based rule (Ex. 30–1294, DC67, Tr. 9070–74, 12277, 13633, 10631, 10636). Mark Davidson, of the Oregon Self Insurance Association, preferred a proactive approach because:

> If the goal is to cut down on the occurrence of MSD complaints, shouldn't the regulatory effort [focus on] preventing the occurrence rather than punish it (Tr. 13633).

Anthony Barsotti, of Hoffman Construction Company, said that an incident-based approach was ''heading backwards in terms of prevention'' versus reaction:

> [H]aving the standard be triggered by the injuries seems inconsistent with where we have been going, both as a safety profession and as a society in terms of identifying hazards, developing systems and processes to control them. And then, kind of when those systems fail and we have an injury, then what are our back-up systems and our approaches? (Tr. 12277).

See also (Tr. 9115–16).

OSHA has carefully considered these comments. In response, it has added a proactive element to the definition of an MSD incident. MSD signs and symptoms that last for 7 consecutive days since first reported to the employer are considered MSD incidents under this standard. Several health care professionals testified that, in most cases, MSD signs and symptoms are completely reversible when they are caught at such an early stage (see, *e.g.,* Exs. 37–1; 37–2, pp. 14–15; 37–12, p. 5; 37–16, p. 8; 37–17, p. 4; Tr. 7687–88, 9884, 13397–98, 13410). Thus, OSHA has concluded that its incident-based approach can prevent employees from experiencing permanent damage or disability, while at the same time minimizing burdens for employers who have few or no ergonomics problems (Ex. 16969–70).

Where employers have provided their employees with appropriate information to allow the employees to recognize MSDs and MSD signs and symptoms, and have also instituted good reporting systems, and employees still are not reporting MSDs, a full ergonomics program may not be necessary. OSHA agrees with commenters who said that a purely hazard-based approach, which would require all employers to analyze all jobs, regardless of whether those jobs have ever caused an MSD, might result in an inefficient use of resources (Exs. 500–1–329, 500–75, Tr. 3095).

This is particularly true because the vast majority of employers will not have an MSD incident reported in their workplace during any given year (Exs. 30–542, 30–3167, 500–1–128, Tr. 2980, 3073, 3096). One report prepared for the Small Business Administration's Office of Advocacy estimated that as many as 75 percent of manufacturers employing fewer than 11 employees are not likely to experience any MSD incident for up to six years. (Ex. 30–542). (See also Ex. 500–67; Final Economic Analysis, chapters II and IV). The testimony of a number of hearing participants representing small businesses confirmed this (Exs. 30–3167, 500–1–128). They told OSHA that they had never had a report of an MSD in their workplace (Tr. 2980), did not have MSDs every year, or had only isolated or few occurrences (Tr. 3073, 3096). Small employers comprise 75 percent of all private industry establishments (Final Economic Analysis, Industry Profile, chapter II), and the incident trigger ensures that most of these employers will have only minimal obligations under the final rule.

The record also shows that an incident trigger is a reasonable proxy for an increased risk of exposure to MSD hazards. For example, some employers with successful ergonomics or safety and health programs use reports of MSD symptoms or symptom surveys to identify jobs posing MSD hazards (Ex. 37–2, Tr. 5503, 5358; Tr. 14707, 14723–26). Dr. Frederick Gerr, Associate Professor of Environmental and Occupational Health at the Rollins School of Public Health at Emory University, testified:

> The use of reported cases of illness, such as MSDs, to trigger investigation into potentially excessive exposure to known MSD hazards is a well-established method of protecting others with similar exposures (Ex. 37–2, p. 15).

Many employers also use MSD reports as a way to prioritize their control activities (Tr. 10631, 14723, 14746). Sean Cady, of Levis Strauss & Co., testified:

> If we have repetitive motion injuries or musculoskeletal disorders on various jobs that occur at the same time how do we prioritize which jobs we select for job modification, because we don't have unlimited resources in the company. So what we do is we review many factors of that job and we qualitatively prioritize jobs. And we review things like the number of symptoms reported on a job, possibly the number of injuries, or the severity of injuries on a job (Tr. 14723–24).

OSHA has made clear throughout this rulemaking that a portion of its intent is to require more employers to implement the kinds of effective programs that are already in place in many industries (64 FR 65770). Incorporating an approach already in wide use is consistent with this purpose, and will reduce employer burden while increasing compliance with the standard.

Other commenters were concerned that OSHA's use of an incident trigger would doom those preexisting programs that involve what these participants view as a more proactive method of identifying ergonomic hazards (Ex. 500–1–452, Tr. 9070–74, 10630–32). But nothing in this rule prohibits employers from taking action, analyzing jobs or setting up an ergonomics program before MSD incidents are reported. And the grandfather clause in paragraph (c) of this standard specifically allows qualifying employers to continue their preexisting programs. Based on the record, OSHA expects that many employers who have established ergonomics programs that do not rely on MSD reports to identify MSD hazards will maintain those programs (Tr. 3130–33, 5539, 9070–74, 10631).

2. One MSD Trigger

A separate group of rulemaking participants complained that the single-incident trigger in the proposal was too sensitive (Exs. 30–2208, 31–324, 500–1–27, 500–1–28, 500–1–45, 500–1–128, 500–52, 500–75, Tr. 5506–07). For instance, the Association of Independent Corrugated Converters said that the ''one-incident threshold makes full coverage a virtual certainty for virtually every sizable employer, and for the vast majority of small employers'' (Ex. 500–1–128, Tr. 16930–31). The National Tooling and Machining Association also said that a single MSD incident was too low a threshold:

> On its own, a single reported MSD might not be statistically significant to warrant the corrective measures required by the proposed regulation. NTMA contends that a trigger mechanism of at least two MSDs should be the minimum threshold for the full program, especially for small businesses (Ex. 500–2).

Jack Pohlman, of the American Foundryman's Society, added that a report of one MSD ''is simply not indicative of systematic problems'' (Tr. 5636). Marathon Ashland Petroleum agreed, saying that a single incident ''is not reflective of the true nature of risk that exists in a given facility'' (Tr. 5540). And the National Paint and Coating Association complained that a one MSD trigger was biased against large employers (Ex. 30–4340).

A number of commenters said that a one MSD trigger also would unduly burden employers by requiring them to respond to ''every ache and pain'' an employee reports (Exs. 30–4340, 500–1–18 (''a single complaint of pain''), 500–1–385, 500–1–386, Tr. 8772 (''perceived minor problems''), 12256). The National Telecommunications Safety Panel testified:

> Extremely minor conditions with little or no connection to the workplace may trigger the standard in many facilities (Tr. 8774).

Several commenters said that the one MSD trigger ignores that ''unique physical characteristics'' or ''predisposing medical conditions'' of the worker may be involved (Exs. 30–328, 30–1651, 30–2208, Tr. 5560–61). James Haney, of Wisconsin Manufacturers & Commerce, said:

> Thus, the most injury- or illness-prone employee becomes the benchmark for implementing the proposed standard's requirements (Ex. 500–1–27).

Finally, some commenters argued that imposing a one MSD trigger would be very costly for employers (Exs. 30–2208, 30–4340, 500–1–26, Tr. 8772). David Potts of the National Electrical Contractors Association testified:

> [B]ecause [of] the broad scope of what constitutes an MSD, the program standard's coverage will be easily activated. As such, an employer could be required to institute costly job analysis and corrective actions as a result of a single injury illness to an overly susceptible employee while all other employees in the same operation or job location has no discernable adverse reaction. Considering this hair trigger and that the Agency has only offered general remediation measures in the proposed rule, small business will surely face burdensome compliance responsibilities and stressful decisions including where to best place their limited resources (Tr. 5645).

These commenters urged the Agency to adopt a MSD trigger having a higher threshold. A number of commenters urged OSHA to increase the trigger to two or more MSDs (Ex. 30–3731–1, 500–2, 601–X–1). Other commenters said that incidence rates should be used to trigger action (Exs. 30–3845, 30–3853, 30–4137, 32–77–2, 500–1–128, Tr. 5370, 8842). Several commenters recommended that the trigger be a ''pattern'' or ''cluster'' of MSDs or MSD reports (Ex. 32–330–1, 500–23–1, 500–92). Paul Adams, director of ergonomics at Owens-Corning, suggested that OSHA should adopt a set of alternative triggers from which employers could choose (Tr. 10630, 10633).

OSHA believes many of these concerns resulted from a misunderstanding of the screening criteria in the proposal. However, the Agency also recognizes the validity of the concerns that those screening criteria were not clear enough to provide adequate assistance to employers trying to screen out non-work-related MSDs (Exs. 30–1722, 30–3956, 500–18, Tr. 8847, 16969–70). OSHA has addressed these concerns through the new definition of ''MSD incident'' in paragraph (e)(1) and the Basic Screening Tool in Table 1. The result is a single-incident trigger that is only half of the standard's action trigger and does not, by itself, require employers to implement a full ergonomics program or impose other substantial obligations on them.

A single-MSD trigger is appropriate for this purpose. Most important, a one MSD trigger is necessary to prevent the occurrence of serious and disabling MSDs. There is abundant record evidence that early detection and intervention can halt the progression of most MSDs, and reduce their severity (Tr. 7687–88, Ex. 32–450–1). On the other hand, where medical treatment and ergonomic interventions are delayed, it is more likely that conservative treatment will be less effective or will not even be an available option, or that the MSD condition will not be reversible and the employee will be permanently disabled (Ex. 38–285). For example, if carpal tunnel syndrome and other nerve-related MSDs go untreated long enough, damage to the nerves will be irreversible (Ex. 37–17, Tr. 13349 (the nerve dies)). If OSHA included a multiple-incident trigger, the first employee to be injured could become permanently disabled while waiting for other MSDs to trigger the employer's obligations to provide MSD management and ergonomic intervention. This would be particularly likely in small businesses and in workplaces where relatively few people perform the same job (Ex. 32–450–1). In addition, not acting on the first MSD may discourage other employees from reporting their MSD signs and symptoms (Ex. 32–450–1).

The use of a single MSD trigger is also consistent with employer practice. Many employers testified that they respond to all employee reports of injury or illness, including MSDs (Ex. 37–2, Tr. 5358, 5359–60, 5503, 5539, 14707, 14739, 17312–13). Even employers who recommended that OSHA adopt a multiple-incident trigger testified that they themselves conduct investigations of every report of injury, including MSD signs and symptoms (Tr. 2920, 5503, 5358). For example, James Lancour, safety and health regulatory consultant with Southern Company Services, testifying on behalf of Edison Electric Institute, said:

> [We] have a reporting mechanism where signs and symptoms are reported. Then we have, it's turned over to the industrial hygiene group to go out and do a job assessment. And, again, depending upon what they find out it may be something that can be unique to that particular person or workstation, et cetera, or it may require more in-depth analysis. So basically depending upon the job they take a look at what they're trying to determine how simple or complex the problem might be, and then go through and develop an assessment protocol based on that operation (Tr. 2920).

When questioned, no employer testified that it was company policy to wait until a second or third employee gets hurt in a job before investigating the first injury. This suggests that employers understand the importance of responding to each report of injury and, in practice, do not consider it appropriate to ignore individual reports of injury.

Other evidence in the record also shows that a one MSD trigger should not impose an undue burden on employers. As discussed above, most small manufacturing establishments do not experience any injuries or illnesses in any given year (Exs. 30–542, 30–3167, 500–1–128, Tr. 2980, 3073, 3096). In fact, many establishments do not experience any injuries or illnesses over a considerable period. According to a report prepared for the Small Business Administration Office of Advocacy, 75 percent of manufacturing establishments with fewer than 11 employees, 50 percent with 11–50 employees, and 25 percent of those with 50–249 employees would experience almost no MSD incidents in any given 6-year period. (See also Economic Analysis, chapters III and IV.) If this standard were to adopt a multiple MSD requirement, particularly one requiring at least two MSDs in the same job during a single year, injured employees in many establishments might never be provided with needed medical intervention or protection from additional injuries because it would take so long for the triggering event to occur.

The changes in the definition of ''MSD incident,'' and the new Basic Screening Tool, both discussed below, will also help to address the concerns of some commenters that significant employer action will be triggered by the report of ''any ache or pain,'' whether or not it is work related (Exs. 30–1722, 30–2208, 30–3956, 500–52). P.J. Edington, executive director of the Center for Office Technology, said:

> OSHA assumes any discomfort on the job is work-related. That leaves all employers in a continuous and costly cycle of trying to eliminate all ''signs and symptoms'' of MSDs (Ex. 30–2208).

But employers have the right under this final rule to make reasonable determinations that particular MSDs are not work related. And only MSDs severe enough to require medical treatment or a job restriction, or signs and symptoms persistent enough to last for seven consecutive days, have any triggering effect. Moreover, the standard's Basic Screening Tool establishes specific thresholds for the duration, magnitude and frequency of exposure to risk factors that a job must involve in order for an MSD incident in that job to be one that triggers the standard's program requirements.

The final rule also takes into account the concerns of commenters that a single incident trigger ignores the fact that an MSD may be related to the ''unique physical characteristics'' of the worker (Exs. 30–328, 30–1651, 30–2208, 500–1–27, Tr. 5660–61). For example, where the employer has reason to believe that only the injured employee is exposed to awkward postures because he or she is very tall or very short, the employer can limit the response to that individual employee's job or workstation. See paragraph (j), below.

3. Definition of ''MSD Incident''

In this standard, the term ''MSD incident'' means either an MSD that is work-related and:

• Involves a work restriction, or

• Requires medical treatment beyond first aid, or

• Involves MSD signs or symptoms that are work-related and persist for 7 or more consecutive days after the employee reports them to the employer.

Work restriction is defined to mean one or more days away from work, one or more days of limitations on the work activities of the employee's current job or temporary transfer to alternative duty. Reducing an employee's work requirements in a new job to reduce muscle soreness from the use of muscle in an unfamiliar way is not considered a work restriction under this final rule. Also, the day an employee first reports an MSD is not considered a day away from work or a work restriction even if the employee is temporarily removed from work to recover.

Relationship to Recordkeeping Rule. The proposed rule defined a ''covered MSD'' as an OSHA recordable MSD that occurred in a job in which the physical work activities and conditions were reasonably likely to cause or contribute to that type of MSD, and those activities and conditions were a core element or took up a significant amount of the employee's worktime. In this final rule OSHA has changed the term ''covered MSD'' to ''MSD incident'' to dispel any implication that any such MSD immediately triggers a full ergonomics program. Although some participants found the definition of covered MSD to be ''relatively clear'' (Exs. 30–3934, 30–4837; 31–173, 31–186, 31–205, 31–229, 31–347), many more objected that it covered too many MSDs, was too vague, or was improperly linked to OSHA's recordkeeping rule (Exs. 30–1364, 30–1722, 30–2088, 30–3167, 30–3845, 30–3956, 500–73, 500–104, 32–337–1, Tr. 4366, 8226, 10000, 12797, 15977). The new definitions of MSD and Action Trigger in this standard address these concerns.

OSHA received a great deal of comment on the proposal's use of an OSHA-recordable MSD, *i.e.,* an MSD required by 29 CFR Part 1904 to be recorded on the employer's injury/illness log, as a trigger for further action. Many of these comments pointed out potential problems that could be caused by linking an employer's obligations under this standard to obligations and interpretations contained in a separate rule (Exs. 30–3853, 30–4137, 32–77–2, Tr. 10632). This problem was highlighted by the facts that OSHA has proposed to amend its recordkeeping rule, so that it has not been clear at any stage of this ergonomics rulemaking what the definition of an OSHA-recordable MSD would be, and that OSHA incorrectly described the recordability of one class of MSDs in the proposal (Exs. 30–3853, 32–78–1, 32–300–1). Moreover, according to commenters, linking the definition of MSD incident to the recordkeeping regulations would give employers a strong incentive to underreport MSDs or would punish employers who already have effective early intervention programs (Exs. 30–46, 30–75, 30–137, 30–1294, 30–1902, 30–4137, Tr. 8848, 10630–32).

OSHA agrees that these concerns, particularly those related to the ongoing recordkeeping rulemaking, outweigh any potential benefit employers would gain from being able to use recordability criteria to determine whether an MSD report triggers further action under this standard. Therefore, in this final standard, OSHA has dropped any reference to the recordkeeping rule's recordability criteria. Although the definition of an MSD incident in this standard uses criteria similar to those used in determining recordability, each of the criteria used in this rule is supported by evidence in this rulemaking record. This has also allowed OSHA to tailor the definition of an MSD incident so that it more closely corresponds with the purposes of this standard.

Definition of ''musculoskeletal disorder.'' For purposes of this rule, an MSD is a disorder of the soft tissues, specifically of the muscles, nerves, tendons, ligaments, joints, cartilage, blood vessels and spinal discs that is not caused by a slip, trip, fall, or motor vehicle accident. See paragraph (z). This standard covers MSDs affecting the neck, shoulder, elbow, forearm, wrist, hand, back, knee, ankle, and foot as well as abdominal hernias. It does not, however, cover eye disorders, even when associated with jobs involving computer monitors.

Although some commenters recommended that the standard address conditions resulting from slips, trips, and falls (Ex. DC 58, DC 405), those injuries are not caused by exposure to the risk factors this standard covers. For the same reason the final rule does not cover computer-related eyestrain, which is caused by factors such as glare from lights and windows, computer flicker and other monitor resolution problems, and by not blinking or looking away from the screen (Tr. 16159–66).

''Work-related.'' In paragraph (z), ''work-related,'' is defined to mean that a workplace exposure caused or contributed to an MSD incident or significantly aggravated a pre-existing MSD. This is a change from the proposal, which would have considered an MSD work-related if physical work activities and conditions caused or contributed to an MSD or aggravated a pre-existing one. Many commenters complained that the proposed definition of work-related, in essence, established a presumption of work-relatedness (Exs. 30–1722, 30–3934, 30–3956, DC65, 500–1–28). The Chamber of Commerce said that the rule should not cover ''minimal workplace exposure that merely aggravates non-work exposures'' (Ex. 30–1722, p. 62). Mike Edmunds, corporate safety director for Tyson Foods, said:

> Even if upper extremity musculoskeletal pain (*e.g.,* wrist pain) arises solely as a result of non-work-related activities, it is virtually impossible for an employer or physician to establish that subsequent work activities did not in some minor way 'aggravate' or 'contribute' in some way to the condition—regardless of the job (Ex. 30–4137).

To address this concern, a number of commenters recommended incorporating language from various State workers' compensation regulations so that an MSD would be considered work-related only where work was the predominant cause of the injury or was more than 50 percent responsible for the injury (Exs. 30–3934, 32–77–2, Tr. 5507). Others recommended that OSHA adopt the definition of work-relatedness from California's ergonomics standard, *i.e.,* that work must be 51 percent responsible for the MSD (Ex. 32–300–1). Several suggested that the MSD incident not include pre-existing MSDs (Tr. 3097–98).

OSHA believes that some of these concerns resulted from a misunderstanding about what ''contribute to'' means. It does not mean that an MSD is considered to be work-related if work contributes in some de minimis (*e.g.,* ''1% contribution'' (Ex. 30–3934)) or vague way. Rather, work contributes to an MSD if a specific physical work activity or condition can be identified as having contributed in some discernable way to the onset of the MSD or the signs or symptoms of an MSD. If nothing specific can be identified as a factor, then work is not considered to have contributed to the MSD.

OSHA also has responded to concerns that, once an employee has an MSD, minor aggravations of the MSD can occur very easily (Tr. 3315). In the final rule, only ''significant'' aggravation of a pre-existing MSD is considered to be an MSD incident. ''Significant aggravation'' occurs only when risk factor exposures in the workplace aggravate a pre-existing MSD to the extent that it results in an outcome that it would not otherwise have caused. For example, workplace exposure is considered to have significantly aggravated an employee's pre-existing MSD if the MSD would have resolved on its own or with only first aid, but because of the employee's exposure to identified risk factors in the workplace, the MSD has progressed to the extent that medical treatment is now necessary. On the other hand, if an employee experiences more pain when at work, simply because the employee is using an injured body part, that extra pain does not constitute significant aggravation. In addition, workplace exposure aggravates an MSD only where a specific physical work activity or condition can be identified as a factor in the progression of the pre-existing MSD.

Although the employer is ultimately responsible for determining whether an MSD is work-related, employers may consult with others, such as HCPs or safety and health personnel at the workplace, in making that determination. Where an employer uses an HCP to provide assistance in determining the work-relatedness of an MSD, the HCP must use the definition of work-related in this final rule and not criteria for determining work-relatedness under workers' compensation.

Another frequent objection to the proposed definition was that it did not establish an adequate severity threshold and, as a result, would have captured all the ''aches and pains of life'' that employees experience while performing work activities (Ex. 30–3956, see also Exs. 30–1722, 30–2208, Tr. 9824). The Chamber of Commerce said that MSD was ''so loosely defined as to cover unverified complaints of pain rather than just objectively verifiable medical conditions'' (Ex. 30–1722, p. 61). The severity criteria in the final rule address this complaint. In deciding to include within its definition only those MSDs resulting in a work restriction, in medical treatment beyond first aid, and in MSD signs or symptoms lasting at least 7 days after being reported to the employer, OSHA is adopting appropriate medical severity thresholds.

Work restriction. A work restriction in this context means at least one full day when the injured employee either must take off the entire work day for recuperation or medical treatment, or is able to work for only a portion of the workday or to perform only some job functions, either regular or alternative tasks, during the recovery period. The latter category includes job transfer, light duty jobs, and alternative duty jobs. Employees who cannot work regularly scheduled or mandatory overtime during the recovery period are also considered to be on work restriction. Neither the initial day on which the MSD is reported or occurred, nor any day on which the employee is not scheduled to work, is counted as a day of work restriction.

On the other hand, the standard now makes clear that work restrictions do not include situations where an employer adjusts the work assignments to deal with the temporary muscle soreness that an employee may experience as a result of starting a job that requires the use of muscles in an unfamiliar way (paragraph (z)). The record indicates that some employers have ''conditioning'' programs, most often lasting about two weeks, to help employees adjust to this type of new job assignment (64 FR 65955 (Case Study No. 2), (Exs. 26–1175, 30–4340, Tr. 9225, 9403, 13589). These programs recognize that it is not uncommon for employees to experience pain or stiffness when they begin exercising muscle groups in new or more strenuous ways (Exs. 26–1175, 30–4340). In these situations, pain or soreness may not indicate the presence of an MSD hazard. In most cases these symptoms resolve as the employee becomes accustomed to the physical activities of the job (Ex. 26–1175). They do not indicate that a hazard needing to be controlled may exist. OSHA believes that this clarification will help alleviate the concerns of some commenters that the single-incident trigger would not only trigger coverage of passing aches and pains, but could also trigger WRP obligations for employees who experience symptoms while they are becoming accustomed to a new job (Ex. 30–4340, Tr. 4316–17).

Medical conditions that result in work restrictions are widely recognized as serious (Exs. 26–1039, 37–1, 37–12, 37–28). Repeatedly, physicians and other HCPs testified that they consider MSDs that rise to this level to warrant both medical evaluation and intervention and job interventions (Exs. 37–1, 37–12, 37–28). Accepted standards of clinical practice, reflected in guidelines published by medical associations, also recommend intervention at least at this stage (Exs. 37–12, 500–34, 26–1039). For example, guidelines on low back disorders (developed by a panel of private sector clinicians for the Agency for Health Care Policy and Research that recommend strategies for assessing and treating low back problems) defined low back problems as ''activity intolerance due to low back symptoms,'' such as pain (Ex. 26–1039, p. 1).

The insurance industry also considers conditions that are severe enough to require work restrictions to constitute medical disability (Exs. 37–1, 37–6, 37–12, 37–28). These conditions are often compensable through workers' compensation, and insurance companies consider them to be serious (Ex. 37–6). According to Stover Snook, former director of the Ergonomics Laboratories at Liberty Mutual Insurance Company who conducted ergonomics research at the company for more than 30 years, the accepted definition of ''low back disability'' in the insurance industry is ''lost time or restricted duty that results from low back pain'' (Ex. 37–6, p. 3).

Medical treatment beyond first aid. The definition of MSD incident includes MSD signs and symptoms that require medical treatment beyond first aid. This is a familiar concept that is also used in OSHA's recordkeeping regulation. It also makes no difference whether an employee obtains medical treatment from his or her own HCP or one selected by the employer; or whether the employee obtains medical treatment before or after reporting the MSD signs or symptoms to the employer. Physicians and other HCPs testified that MSDs that require medical treatment such as physical therapy, prescription medication or surgery are more serious than conditions where resting the injured body area is enough to allow the injury to heal (Exs. 37–1, 37–12, 37–16, 37–17, 37–28).

Persistent MSD signs or symptoms. The third type of MSD incident is MSD signs or symptoms that persist for at least 7 days after being reported to the employer. ''MSD signs'' are defined in paragraph (z) as objective physical findings that an employee may be developing an MSD. MSD signs include deformity, decreased grip strength or range of motion, and loss of function. Some signs are readily observable, for instance, loss of function when an employee with carpal tunnel syndrome cannot hold a powered hand tool because of muscle atrophy in the hand. Other signs, commenters said, may not be as observable to non-HCPs (Tr. 7677). For this and other reasons, MSD signs are treated in the same way as MSD symptoms in the final rule. Under the proposed rule, any MSD sign would have been a ''covered MSD'' because it is a recordable event under OSHA's recordkeeping rule. This raised concerns for a number of commenters, who pointed out that some signs, such as redness, may be mild and transitory, not warranting a full program response (Exs. 30–3344, 30–3749, 30–4674, 32–211).

''MSD symptoms,'' as defined in paragraph (z), are other physical indications that an employee may be developing an MSD. Symptoms include pain, numbness, tingling, burning, cramping, and stiffness. The proposed rule would only have addressed persistent symptoms in manufacturing and manual handling jobs, and then only if the employer knew that an MSD hazard existed in the injured employee's job.

A number of commenters opposed the proposal's inclusion of persistent symptoms in its trigger mechanism (Exs. 30–623, 30–898, 30–1722, 30–4777, 30–4821, 32–78, Tr. 10634). Some recommended at least limiting the types of symptoms included in the definition of an MSD incident (Ex. 32–78, Tr. 10634). For example, ORC said:

> At a minimum, * * * OSHA must limit coverage to those symptoms that can be medically verified and that fall somewhere in the severity range between minor/transient and severe enough to interfere materially with job performance (Ex. 32–78, p. 17).

Other commenters, however, agreed with the inclusion of persistent symptoms in the incident trigger (Ex. 500–218, Tr. 12295), and virtually all of those urged OSHA to extend this criterion to all jobs, not just those in manufacturing and manual handling (Exs. 32–198, 500–218). A number of HCPs were among those supporting, including persistent signs and symptoms in the MSD incident trigger (Exs. 37–1, 37–12, 37–28, Tr. 7660, 13349). They said that persistent signs and symptoms should be evaluated because, left untreated, they often progress into more serious disorders and permanent damage (Tr. 7660, 7884, see also Ex. 32–450–1). One study has shown that employees experiencing MSD symptoms alone are at approximately 2 to 4 times the risk of being off work as employees without such symptoms (Ex. 500–71–27). A number of employers now encourage employees to report signs and symptoms to prevent such results and related costs (Tr. 5539, 5550, 14707, 14739).

The record establishes clearly that MSD signs and symptoms that persist uninterrupted warrant further investigation (Ex. 30–4468, 500–71–27, 37–12, Tr. 1531, 13382, 1763–65). Sound medical judgment supports intervening when an employee has experienced at least a week of MSD signs or symptoms. Dr. Bradley Evanoff, Assistant Professor of Medicine at Washington University School of Medicine specializing in research and clinical practice addressing occupational MSDs, testified:

> I think whatever the occupation, whatever the type of work, if someone has had persistent musculoskeletal symptoms for some period [of] time, and I think a week is a reasonable period of time, then they should be evaluated to see if they have a musculoskeletal disorder (Tr. 1531).

Dr. Robin Herbert, medical director of the Mount Sinai Center for Occupational and Environmental Medicine, testified that providing early intervention for employees whose symptoms persist beyond a few days is ''consistent with accepted medical practice'' (Tr. 1653). In fact, according to ACOEM, such intervention is ''essential'' (Ex. 30–4468). Dr. Robert Harrison, who has treated more than 1,000 patients with work-related MSDs over the past 20 years, and has also conducted research in the area of work-related MSDs, testified that there is ''broad consensus among the medical profession that effective treatment and prevention of MSDs relies on early reporting of symptoms. * * *'' (Ex. 37–12). He also summed up why 7 days is an appropriate threshold:

> [S]even days is early enough to catch the symptoms early but is late enough so that transient symptoms that may last only two or three days don't come through as a reportable symptom to a health care provider. I think it's a reasonable line (Tr. 1764).

The record shows that where signs and symptoms persist beyond a few days, they are likely to indicate that an MSD has occurred. Dr. Gary Franklin confirmed that MSDs can develop in a very short period of time:

> If I was taking the history of the person and getting these kinds of symptoms of numbness and tingling and burning particularly at night, it would not matter to me whether it was two days or seven days or 14 days, if I thought clinically the symptoms were correct. I have seen patients that developed [carpal tunnel syndrome] in a day or two (Tr. 13382).

HCPs also testified that employees who have had MSD signs or symptoms for only a short period of time can already be experiencing physiologic changes or damage (Ex. 37–16). For instance, Dr. Evanoff testified:

> I think people who have prolonged symptoms, lasting more than a few days * * * if you want to use the cut off of a week

or more, I think that that's very likely to represent some underlying tissue damage. * * * (Tr. 1563).

Peter Boyle, former professor of orthopedic physical therapy, agreed:

A large amount of force in a short time could create a pathoanatomic injury causing disruption, and [tissue] failure (Tr. 2797–98).

In addition, persistent signs and symptoms can themselves be severe enough to interfere significantly with major life activities (Tr. 13356. 13360, 13373). Dr. Connell testified:

A typical carpal tunnel patient would come in complaining of numbness and tingling in the distribution of the median nerve. Typically it occurs initially at night and wakes one out of a sleep for some reason—4 a.m. seems to be the magic number (Tr. 2817).

Moreover, the persistence of signs and symptoms can be an indication that an MSD is worsening, and early detection and intervention are ''critical to prevention of more serious disorders,'' in the words of Dr. Robert McCunney, president of the American College of Occupational and Environmental Medicine (ACOEM) (Tr. 7660). Dr. Marc Connell, an orthopedic surgeon at Georgetown University Hospital, added: ''I think that's common medical sense that the earlier the treatment is rendered the less severe will be the MSD'' (Tr. 2833). Dr. Edward Bernacki, vice-president of ACOEM, said:

Obviously, the earlier you pick up a problem, the more reversible it is, so obviously, the encouragement of employees to come in at the first signs of a problem, so that we could work it up, and then basically start treating the illness when it is reversible, in other words, if you have irreversible nerve damage, that is basically too late. Then, you need surgical intervention. However, for example, in carpal tunnel early on when the disease is reversible, mere splinting and restriction of activities are fine, it takes care of the problem, it disappears (Tr. 7687–88).

(See also Exs. 26–1367, 32–450–1, 37–24, Tr. 1530, 1697–98, 2853, 2833, 7649–50, 7687–88, 7883–84, 9831.)

In addition to reducing the severity of MSDs, early intervention has been shown to reduce MSD rates and associated medical costs (Exs. 32–12, 32–339–1–87, 32–399–1–4, 32–450–1 (citing Hales *et al.* 1993)). Dr. Bernacki described a study of the effect on 22,000 employees at Johns Hopkins Hospital and University of an ergonomics program that stressed early reporting of MSD signs and symptoms (Ex. 32–399–1–4, Tr. 7691–92). The study reported an 80 percent reduction in MSDs after the program and early intervention were implemented.

Early intervention also increases the availability and effectiveness of conservative therapy. Several HCPs told OSHA that, when MSDs are treated early, symptoms ''have been completely resolved with a brief period of restricted work activities'' (Ex. 37–12, Tr. 13345–46). Dr. Harrison said:

Employees often rapidly and completely recover from their MSD with simple modification of the work process or change of job duties to minimize or reduce exposure to ergonomic risk factors (Ex. 37–12, p. 5).

Dr. Franklin added that where employees with carpal tunnel syndrome are provided with early intervention they should be able to return right away to modified work and that work restrictions should not be needed for a prolonged period of time (Tr. 13345–46). Dr. Bernacki testified that, as a result of the early reporting and intervention program at Johns Hopkins, there had been only one surgery for work-related carpal tunnel syndrome during the past 5 years, compared with 26 such surgeries in the previous three years (Exs. 32–399–1–4, p. 7–8).

Early intervention also is likely to be more effective in helping patients recover fully (Exs. 37–12, 38–222, 38–451, 500–71–57). Dr. Harrison said:

At an early stage of symptom management, treatment with anti-inflammatory medications, splints, and rest of the affected body part often results in complete clinical improvement without any permanent injury (Ex. 37–12, p. 5).

Dr. Michael Erdil, medical director of the Connecticut Occupational Health Network, said that both scientific evidence and his own clinical experience show that conservative therapy is much more likely to be effective as an early intervention (Ex. 37–16, citing Kruger *et al.* (1991) (Ex. 26–910), Gelberman *et al.* (Ex. 26–916) (1980), Quebec (1987), Zigenfus *et al.* (2000) (Ex. 38–285). Zigenfus found that patients with low back injuries who were provided with medical treatment earlier (*i.e.,* less than 8 days after injury) required fewer days away from work and restricted work and had shorter case duration (Ex. 38–285). Dr. Evanoff explained that the medical literature consistently shows that:

[C]onservative management of MSDs is most effective when begun in early stages of these disorders, and that patients who are treated only after a prolonged symptomatic period are less likely to respond favorably than those treated earlier (Ex. 37–1, citing Dellon (1989), Stern (1990), Rystrom & Eversman (1991)).

Similarly, Dr. McCunney of ACOEM testified that:

ACOEM supports the requirement of a mechanism for employees to report MSD signs and symptoms since early detection is critical * * * [M]y colleague and I can regale you with all sorts of anecdotes about people who have waited too long to seek medical treatment, and then once they come for medical treatment, the treatment is not as effective as it could have been were they to have come earlier (Tr. 7649–50).

Dr. Harrison discussed the case of one worker who did not receive early intervention:

[A] twenty-five year old machine operator recently came into my office for treatment of severe hand pain and swelling. She had worked 9 months in a job that required her to use excessive force to press a lever over 20,000 times per day, using her hands in a pinch grip with her wrist in an awkward posture. She had developed symptoms after three months of work, but had not seen a health care provider after her supervisor told her that she would ''feel better'' after she ''got used to the job.'' By the time she finally came to see me, she was unable to drive her car, shake my hand or open a door. My examination showed marked swelling and redness of the right wrist, and the pain was so severe she cried [at] my touch or gentle movement. My diagnosis was chronic, stenosing tenosynovitis. I had little option but to remove her from work completely for four weeks to let the hand rest. Unfortunately, she was unable to return to work in spite of corticosteroid injections, splints, analgesic medication and physical therapy. She required surgery to release the tendon, and is now in a prolonged rehabilitation program.

This case is not unusual. (Ex. 37–12).

By including persistent signs and symptoms within the standard's definition of an MSD incident, OSHA assures that early intervention can occur and that medical outcomes like that described by Dr. Harrison will not occur.

For these reasons, a number of HCPs and employers said that they investigate MSD signs or symptoms as soon as they are reported (Exs. 30–390, 30–398, 500–218, Tr. 5539, 5550, 9906, 13382). Dr. Franklin stated:

If I was taking the history from the person and getting these kinds of symptoms of numbness and tingling and burning particularly at night, it would not matter to me whether it was two days or seven days or 14 days, if I thought clinically the symptoms were correct. I have seen patients that developed [carpal tunnel] in a day or two (Tr. 13382).

Several employers said that their standard response is to investigate any report of MSD signs or symptoms (Tr. 5539, 5550, 14715–16). Sean Cady, of Levi Straus & Co., said:

Well we believe that symptoms could be precursors to a possible repetitive motion injury. And therefore if we know about a symptom early we can evaluate a job for ergonomic risk factors and possibly modify that job to reduce risk factors prior to the possible occurrence of an injury. And also, early reporting of symptoms is a trigger for our quick response system or quick response process (Tr. 14715–16).

Some employers provide restricted work when an employee reports MSD signs or symptoms to let the symptoms resolve quickly without medical treatment, and to allow the employer to examine the job (Ex. 26–1370). Other employers said their standard practice is to send any employee who reports MSD signs or symptoms to an HCP immediately (Tr. 3867).

These employers told OSHA that their early intervention programs, particularly restricted work and light duty, have proven to reduce the severity and costs of MSDs significantly (Ex. 30-4137). Even after the rule becomes effective, OSHA believes that employers who have seen the advantage and effectiveness of such intervention programs will continue to follow them rather than delaying intervention while they wait to see whether the employee's MSD signs or symptoms persist. However, for those employers who have not yet implemented early intervention programs, including the persistent signs and symptoms criterion in the final rule will help to ensure that employees are provided with appropriate MSD management and work restrictions while their condition is still reversible.

This evidence is part of the reason that OSHA does not agree with the commenters who argued that signs and symptoms are too subjective and difficult to verify to be an appropriate trigger for action under this standard (Exs. 30–1722, 30–3345, 30–4340, 500–1–23, 500–1–117, Tr. 5507). Other evidence establishes that MSD signs are often easily observable (Tr. 2828). For example, an employee's decreased range of motion can be identified by the employee's inability to raise his arms above his shoulders or to bend over to lift an object. Objective physical findings also include positive results on medical tests such as nerve conduction velocity tests, CT scans, or x-rays.

The presence of MSD symptoms can also be confirmed through physical examination by an HCP (Ex. 37–12, 37–28, Tr. 13404). Dr. Robert Harrison testified that there are several ways to confirm the presence of both MSD signs and symptoms, including palpation or movement of the affected body part during the physical examination (Ex. 37–12). Dr. Gary Franklin, of the University of Washington School of Public Health and Community Medicine, testified that symptoms of carpal tunnel syndrome, for instance, can be verified through absence of reflexes and nerve conduction tests and even the Katz hand paint diagram (Tr. 13380, 13404). According to Dr. Franklin, the best case definition of carpal tunnel syndrome is the presence of symptoms plus a positive nerve conduction test. However, Dr. Franklin also said that in some circumstances HCPs can reliably determine, based on symptoms alone, whether a patient has carpal tunnel syndrome: ''one could make a reasonable determination based on symptoms alone if you thought it was possible that somebody had carpal tunnel syndrome.'' (Tr. 13384–88). Dr. Margit Bleecker, Director of the Center for Occupational and Environmental Neurology at Johns Hopkins University, testified:

I think as somebody who has worked many years in this area, you certainly can diagnose carpal tunnel syndrome by the history and the physical examination. The only time that you absolutely need to have the EMG is if you're considering surgery (Tr. 16901).

Dr. George Piligian, who is with the Mount Sinai Center for Occupational and Environmental Medicine and for the past 10 years has been treating workers with MSDs, added:

We use principles in medicine, and as you may or may not know, 80 percent of medical diagnoses, all medical diagnoses, not just work-related ones, are arrived at by history and complaints. Then, we add to them, the physical diagnosis, and finally, the testing. This has been the way medicine has gone on for ages, and those who have written the most respectable textbooks say that, and many doctors who go right to the objective number, which they worship, and leave out those 80 percent arrive at the wrong diagnosis, and thereby give the wrong treatment. So, it is still seeing, listening, recording, putting it all together that arrives at the medical diagnosis, and they can be arrived at (Tr. 7851–52).

OSHA has, however, responded to the comments that certain MSD signs, such as redness, may be transient or may be a sign of something other than an MSD (Tr. 5507). As mentioned, in this final rule, MSD signs are treated the same way as MSD symptoms, so that only those signs that persist for 7 days after being reported to the employer or that meet the other severity criteria require further action. The proposal would have required action whenever an employee reported an MSD sign because all positive signs must be recorded under OSHA's recordkeeping rule. OSHA has also eliminated the reference in the proposal to Finkelstein's, Phalen's and Tinel's tests as examples of the kinds of positive tests that would constitute MSD signs. The record shows that these tests are not considered reliable by a growing number of HCPs and, in any event, have been replaced with other medical tests such as nerve conduction tests (Ex. 37–2, Tr. 13363, 13375).

Other differences between the proposed definition of a ''covered MSD'' and this final standard's definition of an ''MSD incident'' further show OSHA's intent not to address the type of minor and transient symptoms that can be expected to resolve spontaneously in a matter of days even without intervention. The final rule, unlike the proposal, does not include the diagnosis of an MSD in the definition of MSD incident. As mentioned, the standard also now makes clear that an MSD is not work-related unless workplace exposures caused or contributed to it, or were responsible for a significant aggravation of a preexisting injury. These changes respond to comments that the proposal could have required a full ergonomics program in situations where workplace exposures contributed only trivially to the employee's condition (Exs. 30–1722, 30–3934, 30–3956, 500–73, Tr. 3097–98).

Clearly, MSDs qualifying as MSD incidents under the definition in the final rule are the types of conditions that OSHA may act to prevent. See Occupational Noise Exposure (29 CFR 1910.95, 46 FR 46236), Occupational Exposure to Formaldehyde (29 CFR 1910.1048, 52 FR 46168, 46234–37), and Section VII (Significance of Risk) of the Preamble. It is even more clearly within OSHA's authority to require employees to investigate them further to determine whether they were caused by hazards that this standard addresses.

Paragraph (f)—How Do I Determine Whether the Employee's Job Meets the Action Trigger?

Paragraph (f) tells employers how to determine whether a job where an MSD incident has occurred meets the standard's two-part Action Trigger. According to paragraph (f)(1)(i), the first part of the Action Trigger is a determination that an MSD incident has occurred. Paragraph (f)(1)(ii) states that the second step is a determination that the injured employee's job meets the Basic Screening Tool in Table 1 of this standard. Paragraph (f)(2) explains that if the job does not meet the Action Trigger, the employer has no further obligations with respect to that job.

The second step of the action trigger requires application of the Basic Screening Tool in Table 1 to the injured employee's job. A job is screened in, *i.e.,* is determined to meet the levels in the Basic Screening Tool, if it regularly involves exposure to one or more of the risk factors in the Basic Screening Tool at levels above those specified in the tool. Only where the job is screened in does the employer have further obligations under the standard.

The proposed rule also included an exposure screen. The proposed screen would have ruled out jobs where the ''physical work activities and conditions'' in the job were not associated with the ''type of MSD reported,'' or were not ''reasonably likely'' to cause or contribute to an MSD. It also would have ruled out jobs in which the employee's exposure to the risk factors was not a ''core'' element of his or her job, or did not make up a ''significant'' amount of the employee's workday.

Thus, the proposed standard contained performance-oriented language (''core element,'' ''significant amount'' of time) to define the terms of the screening criteria. In the preamble to the proposal, OSHA also used performance-oriented language in discussing the meaning of core element, describing the term as a ''regular and routine exposure.'' On the whole, most commenters supported the concept of an exposure screen, but many said that OSHA had not provided enough guidance for them to understand when a nexus existed between an MSD and a job or what the exposure severity threshold was for a job. For example, they complained that the terms were too vague and undefined to answer those questions (see, *e.g.,* Exs. 30–1722, 30–3032, 30–3853, 30–3956, 30–4340, 30–4837, 31–92, 31–125, 31–223, 31–225, 31–260, 31–307, 30–300, 32–337, DC66, Tr. 3337, 8849, 8850).

The following comments are representative:

> The terms ''core element'' and ''significant amount'' are not clear. While extreme examples can be easily defined, extreme examples are few and far between in the real world. Most of the time, examples fall into ''grey'' areas. These terms either need specific definitions or should be replaced with other terms (Ex. 30–4837).
>
> Does [core element] indicate that the employee will be required to perform a manual handling task some time during his/her shift, *i.e.,* one 50-lb. Lift throughout an 8-hour work shift, or does it indicate that some repetition is involved with the manual handling portion of the task, *i.e.,* lifting 20 10-lb. packages per hour for 8 hours? (Ex. 30–4837).
>
> How much is significant? 6 hours per 8-hr shift? 4 hours per 8-hr. shift? 2 hours per 8-hr. shift? Or 22-hr. periods per 8-hr. shift? (Ex. 30–4837).

The Rohm and Haas Company said:

> [I]t is unclear what OSHA means by the subjective terms used as shown below. ''* * * significant amount of their worktime * * *'' * * * [and] ''* * * core element of the employee's job.'' It is unclear how OSHA would be able to determine consistently the applicability of the standard in specific situations in the absence of a criteria to guide decision-making on whether the work time was significant, the applied force was forceful, or whether the material handling was a core element of the employee's job. * * * In the absence of an explanation of what OSHA intends these subjective terms to mean, it is unclear how to decide whether a particular activity fits the definitions and therefore whether it is covered by the standard. (Ex. 31–289)

National Small Business United testified that:

> The employers, especially the smaller employer, * * * needs more specific guidance in terms of the types of jobs to be looking at and specifically as the types of activities in those jobs and how much of what kind of activities is too much for what type of person. (Tr. 2746)

Con Ed stated:

> Throughout the standard, OSHA uses terms that are vague and open to interpretation such as: reasonably likely, core job element and other similar terms. These terms require clarification so OSHA and employers interpret them consistently. (Tr. at 4628)

In addition, ORC added that:

> The proposed trigger simply does not fulfill OSHA's responsibility to provide adequate guidance with respect to employer's obligations. * * * OSHA must do a better job of defining a point at which an employer's obligations are triggered and do a better job in establishing more objective criteria. (Tr. at 4097)

Similar comments were submitted by EEI (Ex. 32–300–1); Chamber of Commerce (Ex. 500–188; Tr. at 3044), Color Works (Tr. at 10069), Indiana Chamber of Commerce (Tr. at 3335), National Roofing Contractors Association (Tr. at 4905), Food Distributors International (Tr. at 5634–35), and many others.

Commenters further recommended that the screening criteria should include specific, exposure-based criteria (Ex. 500–218; Ex. 500–214, Tr. at 17905–6). In particular, ORC stated that:

> In place of the proposed screening criteria of section 902, OSHA would set forth flexible, but objective, risk-based criteria * * * (Ex. 500–214)

ORC added that such criteria are already contained in the record and that ''a number of models to define at-risk conditions and work routines are available in the literature and are cited by OSHA in its preamble.'' (Ex. 32–78–1)

Similarly, the AFL–CIO stated:

> While we believe the content and intent of OSH's proposed screening criteria were clear from the text and Preamble of the proposed rule, the AFL-CIO has several recommendations for ways in which OSHA can respond to industry's requests for more specific guidance and definitions. We recommend two possible approaches. The first is to incorporate a list of risk factors and criteria similar to the ''caution zone job'' criteria included in the state of Washington's Ergonomic Standard (WAC 296–62–0515) which serve a similar purpose as the screening criteria in the federal OSHA proposal. These ''caution zone job'' criteria provide more specific definitions of risk factors and the amount of time or frequency that must be exceeded for these risk factors to be covered by the standard. (Ex. 500–218)

ORC also expressed qualified support for using the state of Washington's ''caution zone job'' criteria:

> Although the Washington State proposal itself contains significant deficiencies, ORC believes its approach to providing quantified alternative triggers is a rational one that could be considered by OSHA. (Ex. 32–78–1)

See also Tr. 9071–74.

A preliminary exposure-based assessment as a trigger for further actions is also widely used by participants in the rulemaking who provided testimony on the specifics of their own ergonomics programs (see, *e.g.,* Ex. 32–300–1, Tr. at 2920–2927; Tr. at 5302, Tr. at 10802; Tr. at 14142; Ex. 32–339–1–4, Tr. at 16839; Tr. at 4643–4647; Tr. at 5539–5540, 5566–5567, Tr. at 14801; Tr. at 14715). Many of these commenters use a checklist format which contained specific descriptions of risk factors. The Dow Chemical Company, for example, uses a short checklist printed on a pocket size card that contains descriptions of specific risk factors along with a duration/timing component (see, *e.g.,* Tr. 5311–5312, 5359, Ex. 32–77–2–1). NIOSH's Elements of an Ergonomics Program (Ex. 26–2), also contains checklists that have specific descriptions of risk factors, some with a duration component.

A number of other participants also suggested that OSHA adopt quantitative methods of defining the screen (Ex. 30–46, 30–75, 30–137, 30–293, 30–328, 30–3032, 30–3284, 30–4837, 31-23, 31–27, 31–95, 31–137, 31–187, 31–31–202, 31–301, 31–307, 31–337). Specific suggestions included defining a core element of manual handling jobs in terms of frequency rates for lifts (Ex. 31–337), or saying lifting was a core element of a job that required one lift per hour (Ex. 31–259). Suggestions for a definition of the term ''significant amount of worktime'' included 50 percent or more of the employee's worktime, Southern California Edison (Ex. 31–23), more than 2 hours a day, UNITE (Ex. 32–198), or routine performance of the same task 4 hours or more per shift or 2 hours or more continuously per shift, Monsanto (Ex. 30–434).

Some commenters thought that the screen would require them to conduct a job hazard analysis every time an MSD was reported, just to know whether the MSD was reasonably likely to have been caused by the job. Rodney Smith of Freeborn & Peters said:

> Identifying ergonomic risk factors is difficult due to the vagueness of their definition [in the proposed rule]. But how in the world does my employer tell whether those risk factors constitute a hazard, as that term has been defined in the standard. That is, risk factors reasonably likely to cause or contribute to a covered MSD (Tr. 8850).

Others also complained that it would be virtually impossible for them ever to establish that it was not reasonably likely that exposure to risk factors in a job could cause MSDs, when at least one MSD would have already occurred (Ex. 30–1722, 30–4137, DC 65). In addition, several commenters found the crucial terms ''extremely subjective,'' and believed they would be ''open to the individual interpretation of OSHA inspectors'' (Ex. 30–3032, 31–22, 31–303, 31–307, 32–337).

In response to those and other comments, OSHA has further clarified and operationalized the proposed exposure screen, or severity threshold. Once the employer determines that an MSD incident has occurred in a job, the employer must screen the job to determine whether it meets criteria requiring a job hazard analysis to determine the potential hazard associated with exposure to risk factors. For ease of use, the criteria are presented in a ''Basic Screening Tool,'' which is a chart that contains specific descriptions of the risk factors covered in the final rule along with duration specifications and illustrations (see Table 1 of the regulatory text). In jobs where an MSD incident has occurred and employee exposure to risk factors meets the criteria laid out in the screen, the employer must proceed with the program requirements in paragraph (g) of the standard.

Employers with employees who report MSDs in jobs that do not meet the specific screening criteria are not required to proceed with any of the remaining requirements of the standard. This could include jobs that do not involve the risk factors this standard covers or where the injured employee's work activities do not involve the injured body area. The screen also allows employers to screen out jobs in which the employee's work activities do not involve enough exposure to risk factors to require further action under this standard. In these cases, the employer need not perform a job hazard analysis, eliminate or control any MSD hazards, or provide training or MSD management. Where application of the screening tool results in a job being screened in, however, employers must implement the ergonomics program described in paragraph (g).

The Basic Screening Tool has been designed to minimize employer burdens in screening jobs. It is similar to a number of screening tools that are already in use (Exs. 26–1008 (Snook Push/Pull Tables), 32–77–1–2 and Tr. 5336–37 (Dow Chemical), 502–12 (NIOSH Lifting Equation), 502–35 (GM–UAW checklist)). It is limited to five risk factors and, to streamline the screening process, the tool applies the same duration criteria to almost every risk factor/activity.

The Basic Screening Tool in the final standard serves the same function as the screen in the proposed rule, but, instead of performance language, it contains specific definitions of the risk factors and exposure durations that define a job requiring further analysis. The definitions used in this chart are consistent with a number of approaches and screening tools contained in the rulemaking record, including the state of Washington's Ergonomic Standard's ''caution zone job'' checklist (Ex. 500–41); the checklists contained in the NIOSH Elements of an Ergonomics Program (Ex. 26–2); the checklist developed by tripartite committee of employer, employees and government representatives for use in conducting a preliminary job analysis under the British Columbia Ergonomics Standard (Ex. OR–388); and others (Exs. 500–108; 32–77–2–1, 26–2, OR–348–1; 502–67)

By utilizing language from programs and checklists that have been used successfully by both employers and employees for many years, OSHA fully anticipates that employers will have no difficulty in determining whether a job meets the standard's Action Trigger. Further, as with the proposed rule, OSHA expects that employers will be able to determine, quickly and efficiently, if the job activities of any employee reporting a MSD meet or exceed the criteria of the screen.

Similar to the concept expressed in the proposed rule, the basic screening tool in the final standard, when coupled with the occurrence of an MSD incident in a specific job, represents an exposure-based ''action trigger'', that requires the employer to proceed with some other provisions of the standard (in particular, job hazard analysis and MSD management). However, jobs where the employer has determined that an MSD incident occurred and that meet the screening criteria do not necessarily require corrective action; the need for corrective action is based on the results of a more detailed job hazard analysis (see Summary and Explanation, Job Hazard Analysis section). In this way, the screening criteria concept is similar to action levels contained in OSHA's health standards (*e.g.*, Benzene, 29 CFR 190.1028; Ethylene Oxide, 29 CFR 1910.1047; Formaldehyde, 1910.1048.) In those standards, as in the final ergonomic program standard, the inclusion of an action level is used to differentiate between more hazardous and less hazardous work operations, and to identify those operations where the employer needs to focus resources.

The screening criteria in the final standard consist of the five risk factors that are covered in the final rule: repetition, force, awkward postures, contact stress, and vibration. Most of the screening tools submitted to the record contained similar risk factors. For example, the screening tools submitted by NIOSH (Ex. 32–30–1–45), UFCW (Ex. IL–228), the AFL–CIO (Ex. 500–71–70), the Worker's Compensation Board of British Columbia (Ex. 500–142–12), the UAW/General Motors (Ex. Or 348–1), Dow (Ex. 502–77–2–1), and the Washington State Department of Labor and Industries (Ex. 502–313–6) included these same five risk factors as specific risk categories in their screens or included narrative questions directly related to or incorporating these same risk factors. In addition, these are the risk factors addressed in the epidemiological literature on ergonomics and discussed in the Health Effects section (Section V) of this preamble.

The proposal also included static postures, whole body vibration, and cold in the list of risk factors. The evidence discussed in the Health Effects section of this Preamble has convinced OSHA that these risk factors should no longer be addressed independently. Static postures will be covered to some extent by the awkward postures element of the screen, and employers should be aware that cold temperatures may aggravate the effects of other risk factors.

To give further guidance to employers, each risk factor in the chart is clearly described (*i.e.,* descriptions of specific job or task activities) and includes specific duration, frequency. and magnitude components. In the chart, repetition includes a separate description for keyboarding/mouse use; force is broken down into lifting, pushing/pulling, and pinching and gripping unsupported objects of specified weights; awkward postures are defined by specific postures, as well as pictures; and vibration includes a description for both high vibration levels from equipment such as chainsaws, and moderate vibration levels from equipment such as jigsaws, grinders or sanders.

In addition, the chart contains a simple grid for employers to use in relating the body area affected by an MSD incident to a relevant risk factor. Thus, the grid serves to further simplify this initial determination by assisting the employer in focusing on only those risk factors that have a clear nexus with the MSD incident that triggered the use of the screening tool; this also reflects OSHA's intent in the proposal. For example, if an MSD of the back or lower extremity is reported, the employer, when evaluating the risk factor for repetition, would focus only on job or task activities where the employee is performing the same motions every few seconds or repeating a cycle of motions involving the affected body part more than twice per minute for more than 2 consecutive hours in a workday. The employer would not need to consider use of a keyboard and/or mouse in steady manner (the shaded portion of the chart under the risk factor repetition). Similarly, for a reported MSD affecting the back or lower extremity, the employer, when evaluating the risk factor for force, would only need to focus on job or task activities involving lifting or pushing/pulling and not on work tasks involving pinching or gripping.

Each job or task activity also includes a duration/frequency limit. In selecting the duration limit for the risk factors, OSHA based its decision on balancing the weight of the scientific evidence against the need for the screening tool to be clear and easy to use. For many items in the chart, the agency has chosen to use more than 2 hours total per day as an exposure duration that triggers jobs for job hazard analysis; this determination is based on an analysis of relevant epidemiological data contained in the rulemaking record.

Many studies in the epidemiological literature clearly demonstrate that the incidence of MSDs increase with increased duration of exposure to certain risk factors or a combination of risk factors. Table IV—SCREEN lists studies that included duration, either qualitatively or quantitatively, as a component of the investigation. These studies reflect a subset of the many studies identified by the Agency that demonstrate positive exposure-response relationships between the intensity and/or duration of exposure to biomechanical risk factors and the prevalence or incidence of MSDs. The results of these studies show increases in odds ratios or other risk measures with increases in the daily or weekly duration of exposure for a number of risk factors such as repetitive precision movements, awkward postures (*e.g.,* hands above the shoulders, kneeling, stooping), gripping, lifting, and carrying. For example, Ekberg *et al.* (Ex. 26–1238) reported that the risk of MSDs of the neck and shoulder increased with the hours per day that repetitive precision movements were performed and that arms were lifted above the head. Similarly, Kelsey *et al.* (Ex. 26–709) reported an increased risk of prolapsed lumbar disc when the frequency of lifting or carrying loads greater than approximately 25 pounds increased from 0 to more than 25 times per day. Similar dose-response observations were reported by Latza *et al.* (Ex. 38–424), Matsui *et al.* (Ex. 26–309), Smedley *et al.* (Ex. 500–41–40) and Tola *et al.* (Ex. 26–1018).

OSHA's review of the studies that quantified duration of exposure indicate that, in general, the MSD risk in exposed groups of workers increases above that in unexposed groups when the duration of exposure to certain risk factors or combinations of risk factors comprises about one-fourth to one-half of the workday or workweek. For example, Holmstrom *et al.* (Exs. 26–1231, 26–36) studied workers using awkward positions such as stooping, kneeling, and raising the hands above the shoulder and found an increased risk of low back pain (Odds Ratio of 1.4, 1.9, and 1.5 for stooping, kneeling and hands above the shoulder, respectively) with 1 to 4 hours per day of exposure. Similarly, Nordstrom *et al.* (Ex. 26–900) observed that the risk of carpal tunnel syndrome began to increase among workers whose jobs involved wrist bending or twisting after exposures of 3.5 hours compared to groups exposed for less than 3 hours (Odds Ratios of 1.34 with 0.25–1.75 hours exposure, 1.23 with 2–3 hours exposure, and 2.33 with 3.5–6 hours of exposure). Similar quantitative observations were reported by deKrom (Ex. 26–102) for wrist flexion, Baron *et al.* (Ex. 26–697) for grocery checking, and Xu *et al.* (Ex. 500–71–53) for frequent twisting and bending and for physically hard work (see Table IV—SCREEN). Other studies reported results using qualitative ordinal scales that indicate that risks increase, sometimes substantially, with exposure to risk factors of one-half a day or more. Ekberg *et al.* (Ex. 26–1238) reported ORs of 3.8 and 2.4 for neck/shoulder disorders that were associated with a ''medium'' duration (in hours per day) of repetitive precision movement or arms lifted, respectively, compared to workers with ''low'' exposure in terms of daily duration. Stetson *et al.*(Ex. 26–1221) found an increased prevalence (65%) of hand/wrist symptoms among workers using a high grip force (> 6 pounds) for more than half of a shift (defined as ''frequently'' in the study), compared to the prevalence in workers with ''some'' (40%) or no (41%) exposure. A study by Viikari-Juntura *et al.* (Ex. 500–41–50) of trunk twisting reported a non-statistically significant elevation in risk of neck disorders (OR = 1.3) among workers having ''little'' exposure (in hours per day), and statistically significant increases in risk among workers with ''moderate'' (OR=1.9) and ''much'' (OR = 2.3) exposure.

However, there were also studies that showed increased risk of MSDs associated with exposures of less than 2 hours daily. For example, Vingard *et al.* (Ex. 500–41–51) showed an increased risk MSDs of low back area among workers in jobs involving forward bending for approximately 1 hour per day (statistically significant for male workers, but not for female workers). Holmstrom *et al.* (Ex. 26–36) found a significantly increased OR (2.4) for severe low back pain with impairment for less than 1 hour per day of kneeling). DeKrom *et al.* (Ex. 26–102) reported a significantly increased OR (1.4) for carpal tunnel syndrome among workers having 1 to 7 hours per week of wrist flexion; 1 to 7 hours per week of wrist extension was also associated with an elevated OR for CTS (1.4), but that result was not statistically significant. Latza *et al.* (Ex. 38–24) reported an increase (not statistically significant) in low-back pain among workers laying sandstone for less than 2 hours per day compared to unexposed workers. English *et al.* (Ex. 26–848) found positive exposure-response relationships where ORs for carpal tunnel syndrome or hand/wrist disorders increased by 1.8 and 1.6 per hour worked per day, respectively, for workers performing tasks involving shoulder rotation once per minute. These studies, taken as a whole, demonstrate that for the risk factors listed in the basic screening tool, the risk of MSDs increased with daily duration of exposure.

The studies described above and contained in Table IV—SCREEN show that, where researchers have investigated relationships between MSD risk and daily duration of exposure, the risk of MSDs has been consistently elevated in groups of workers exposed for half of the workshift or more (Exs. 26–1238, 26–697, 26–1221, 38–428, 26–

1231, 26–36, 26–1018, 500–41–50, 26–102, 26–900, 26–58, 500–71–53). For exposure durations of one-fourth to one-half of the shift, or durations described as ''some'' or ''moderate,'' several studies showed statistically significant increases in MSD risk (*e.g.,* Exs. 26–697, 38–428, 26–1231, 26–36, 500–41–50, 26–102) and others reported increased ORs that were not statistically significant (*e.g.,* Exs. 26–1018, 500–41–50, 26–102, 26–58). For exposures of less than 2 hours daily duration, results from these studies are more equivocal; some reported significantly increased ORs (*e.g.,* Exs. 500–41–51, 26–848, 26–102, 26–36) while several found non-statistically significant increases in ORs (*e.g.,* Exs. 500–41–50, 26–102, 500–41–51, 26–36, 26–1231, 38–24). Based on these studies, OSHA finds it reasonable to trigger jobs for job hazard analysis where employees are exposed to the risk factors indicated on the screen for more than 2 hours during the work shift. OSHA believes that a 2-hour duration criterion for the screen will capture those exposure situations where the epidemiological evidence indicates that MSD risk is most likely to be elevated (*i.e.,* jobs involving more than 4 hours per day of exposure) as well as those jobs involving 2 to 4 hours of exposure during the shift where the evidence suggests that the risk may already be increased, at least in some situations. The 2-hour trigger will exclude those jobs where the evidence has been less consistent in finding an elevated risk of MSDs (*i.e.,* jobs involving less than 2 hours of exposure). This is consistent with OSHA's statutory mandate to be protective of workers. However, because the screen does not necessarily trigger an obligation to control a job, OSHA also is not imposing unnecessary costs on employers.

In using this 2-hour cutpoint, OSHA does not intend to imply that all workers will experience significant adverse effects after 2 hours or more of exposure. Rather, OSHA is using this cutpoint in the screen criteria to give employers guidance about which jobs might involve a sufficient duration of exposure such that the job warrants closer examination. In addition to being supported by the scientific literature, this value is also administratively simple for employers to use, thus allowing the screening tool to be used quickly and consistently for a number of different jobs.

For repetitive motion other than use of a keyboard or mouse, the screen triggers jobs into the requirements of the standard only if the exposure occurs for more than 2 *consecutive* hours in a workday, as opposed to more than two hours total per day. This reflects OSHA's belief, based on the health evidence, that 2 hours of repetitive motion will be less hazardous if spread out over the workday because musculoskeletal tissue will have an adequate opportunity to recover. By capturing only those jobs that involve more than 2 consecutive hours of repetitive motion, the standard will not capture those jobs where employees change tasks during the day, even if the repetitive motion occurs for a total of 2 hours over the work shift.

The screening tool departs from the 2-hour duration criterion for a few items. These include the following: For use of keyboard and mouse in a steady manner, the duration is set at 4 hours total per workday; for lifting, the screen sets weight and frequency criteria; and for use of tools or equipment that typically have high vibration levels (such as chainsaws, jack hammers, percussive tools, riveting or chipping hammers) the duration is set at 30 minutes total per day.

For use of a keyboard or mouse in a steady manner, OSHA has set the duration for more than four hours total per day. In this case, OSHA has chosen more than four hours based on the epidemiological evidence that demonstrates that, in general, the risk of MSDs for workers performing keying activities begins to increase after four hours of exposure (see Table IV—SCREEN). For example, Bernard *et al.* (Ex. 26–842) studied workers typing at video display units and reported an increased risk of hand/wrist MSDs for exposures of 4 four to six hours. Oxenburgh (Ex. 26–1367), observed an increased prevalence of hand, wrist, forearm and/or elbow MSDs after 4 hours per day at a keyboard. Similarly, Polanyi *et al.* (Ex. 38–3) studied keyboard workers and observed that upper extremity MSDs significantly increased after exposure durations of approximately four hours per day. Based on this evidence, OSHA has determined that it is appropriate to deviate from the 2 hour duration criterion set for other job or task activities, and to set a greater than four hours total per day for the use of a keyboard or mouse in a steady manner.

For using tools or equipment that typically have high vibration levels (such as chainsaws, jack hammers, percussive tools, riveting or chipping hammers) OSHA has set the duration at 30 minutes total per day. This level is based on a time-energy equivalent exposure determination. For example, the time duration for using tools or equipment that have moderate vibration levels (such as jig saws, grinders, or sanders) is set at 2 hours total per day. Vibration level can be expressed as the amount of energy transmitted by the tool over a certain period of time (*e.g.,* m/s^2). OSHA assumes that a moderate vibration level is approximately $2.5m/s^2$. The duration for moderate vibration level is more than 2 hours total per day. Assuming that a high vibration level is approximately $10m/s^2$ (4 times the moderate vibration), the time-energy equivalent exposure duration level at which risk is increased for activities involving high vibration levels would be 30 minutes (*i.e.,* ¼ of 2 hours). That is, risks for activities at four times the vibration level would occur ¼ the amount of time.

For lifting, the chart contains specific weight limits, coupled with a specific limit on the number of times per day the weight can be lifted. Weight limits are specified for weights lifted from below the knee, above the shoulder and at arm's length. The limits specified are as follows: lifting more than 75 pounds at any one time; more than 55 pounds more than 10 times per day; or more than 25 pounds below the knees, above the shoulder, or at arms' length more than 25 times per day. OSHA has based these limits on recommendation found in other screening tools as well as evidence in the epidemiological literature that shows increased risk of low back disorders when lifting certain weights at certain frequencies or postures. For example, Arad and Ryan (Ex. 500–41–7) and Smedley *et al.* (Ex. 1249) reported an increase in risk low back MSDs among healthcare workers lifting one to four patients per day. Kelsy *et al.* (Ex. 500–41–73) reported increased risks of lumbar disorder among workers in jobs requiring lifting more than 25 pounds more than 25 times per day compared to workers who did not lift these weight. Similar findings were reported by Macfarlane *et al.*(Ex. 500–41).

OSHA finds that the weight of evidence clearly demonstrates that heavy, frequent or awkward lifting increases the risks for MSDs. Particular studies, such as those described above, provide support for the specific weight criteria used in OSHA's screening tool for the final standard. Washington State has used similar data to support its ''caution zone job criteria'' for lifting (Ex. 500–313–6). OSHA believes that these are reasonable criteria to use for the screening purposes of this standard and that, in general, these criteria reflect the evidence in the record.

The exposure screen also contains an entry for activities involving pushing and pulling. In a questionnaire survey of insurance company policyholders, Snook *et al.*(1978) found 9% of low back injuries to be associated with pushing and 9% to be associated with pulling (Ex. 26–35). NIOSH (1981) cited evidence that 20% of overexertion incidents involve pushing and pulling objects (Ex. 26–393). Thus, OSHA finds that it is appropriate to include pushing and pulling on the screen as a specific exposure criterion.

For job activities involving pushing or pulling, the chart specifies 20 pounds of initial force as the trigger criterion. To provide a basis for determining appropriate workloads for these activities, Snook and Ciriello (1991) developed tables of maximum acceptable forces for pushing and pulling (Ex. 26–1008). Maximum acceptable forces were expressed in terms of the percentage of the industrial population capable of performing the task. Data were presented separately for males or females either pushing or pulling, and were given for both initial forces (the force required to get an object in motion) and sustained forces (the force required to keep an object in motion). Variables included frequency, distance, and height (vertical distance from floor to hands).

The tables were developed based on experiments employing a psychophysical methodology (Ex. 37–6). This approach assumes that workers are able to determine with some accuracy their highest acceptable workload. Subjects were given a task with a set frequency, distance, and height and were allowed to control the amount of force used. Subjects were instructed to work as hard as they could without straining themselves or becoming unusually tired, weakened, overheated, or out of breath.

Although acute fatigue was the basis of the limitations established by this series of experiments, the results have been shown to predict the risk of developing MSDs. Snook *et al.*(1978) reported that workers performing manual handling tasks that less than 75% of workers are capable of performing without overexertion are three times more likely to suffer from low back injuries than those workers performing manual handling tasks that more than 75% of workers are capable of performing (Ex. 26–35).

Other research has also supported a relationship between psychophysically derived exposure levels and risk of MSDs. Using an index derived from the tables developed by Snook and applying it to 6,912 workers in 55 industrial jobs, Herrin *et al.*(1986) found that the number of overexertion incidents was related to the psychophysical stress of the job. The severity of these incidents as measured by lost or restricted work days was also found to be associated with psychophysical stress (Ex. 26–961). Additionally, Park and Punnett found psychophysical ratings of ergonomic stressors to predict the incidence of in-plant medical visits for MSDs among 1064 workers in two automobile manufacturing plants (Ex. 38–160).

Based on the reported association between pushing and pulling and the development of MSDs, and the evidence of a relationship between psychophysically derived exposure limits and reported injuries, OSHA concludes that an exposure criterion based on psychophysically derived limits will serve as a reasonable basis for determining when a hazard analysis is necessary for jobs involving pushing and pulling activities.

The 20-pound force criterion for pushing and pulling will capture all jobs that are designed such that less than 75% of workers (male or female) are capable of performing them without experiencing overexertion. As explained above, lifting jobs that cannot accommodate at least 75-percent of the working population's physical capacity have been associated with a three-fold higher risk of low back disorders. This suggests that jobs should be subject to more detailed hazard analysis if an initial screen indicates that a task involving pushing or pulling is not designed within 75-percent of the working population's physical capacity.

While the screening threshold for pushing and pulling forces is based upon an exposure level that is protective of 75 percent of the industrial population based on psychophysical measurements relating to overexertion, this should not be construed as an endorsement by the Agency of exposure to ergonomic risk factors based on what is considered to be an acceptable level for any given percentage of the population. The level chosen in this instance resulted from the fact that the evidence in the record indicates that an increased risk of developing MSDs exists among workers who perform pushing or pulling activities at levels above those found to be acceptable to 75 percent of the industrial population based on psychophysical measurements relating to overexertion, not because any particular proportion of the exposed population was considered to be protected from developing MSDs.

The 20-pound force criterion for pushing and pulling tasks is consistent with the OSHA ''safe harbor'' for pushing/pulling, which is based on the 90th-percentile values for female workers. Using 20 pounds as screening criteria will help to ensure that employers are not screening in jobs for which they have already implemented controls based on the safe harbor value, but instead are screening in those jobs where risks may begin to occur and for which a job hazard analysis is appropriate.

For performing activities that require pinching or gripping unsupported objects, the chart specifies weights of two pounds or more per hand for pinching and 10 pounds or more per hand for gripping. These values are generally supported by studies such as those by Chiang *et al.* (Ex. 500–41–25), Stetson (Ex. 500–41–44), English (Ex. 500–41–30) and Roquelaure *et al.* (Ex. 500–41–112). These investigators reported increased risks of carpal tunnel syndrome, thumb disorders, shoulder disorders, and nerve abnormalities among workers repetitively pinching objects approximately in the range of two pounds or gripping objects approximately in the range of 10 pounds. OSHA believes that the weights specified represent reasonable screening criteria for identifying conditions likely to cause the type of MSDs reported and are similar to values recommended in other screening tools. While there may be more precise ways of measuring force associated with pinching or gripping, OSHA believes that using the weight of objects handled is more administratively simple for employers to use and thus will enable employers to more quickly and consistently evaluate jobs.

Similarly for contact stress, OSHA has specified a frequency of 10 times per hour when using the hand or knee as a hammer. OSHA believes that this value is also administratively simple and reasonable to use for the screening purposes of this standard. Studies have shown increased risk in MSDs among workers using the hand or knee as a hammer (*e.g.,* Little and Ferguson, Ex. 26–1144 and Thun, Ex. 26–60). However, little data is available that quantifies the frequency of exposure at which increased risks are observed. Washington State chose a value of 10 times per hour for their ''caution zone job'' criteria. OSHA believes that this is a reasonable value to use for screening purposes and that it gives the employer guidance in identifying work activities likely to contribute to the type of MSDs reported.

In summary, the specific description of risk factors contained in the screen, coupled with the duration specifications, all have a sufficient degree of risk to trigger some simple additional requirements (job hazard analysis, MSD management, training and evaluation). It should be kept in mind however, that these are not intended to imply that a hazard exists and requires control be instituted. There is substantial evidence in the record that supports the agency's choice of risk factors and duration levels. As with ''action levels''' contained in other health standards, the duration levels were set at levels where the risk begins to rise and additional, simple steps are necessary.

The purpose of this screen is to focus on those jobs that are likely to have caused or contributed to the MSDs that are reported. In general, activities causing or contributing to such MSDs are more likely to be ones that make up significant amounts of the employee's worktime and represent a core element of the employee's job. As such, these activities are likely to be a foreseeable part of the job that can be reasonably predicted and thus can be taken into account when designing an ergonomics program. These are the types of jobs that OSHA seeks to capture under the final standard so that programs can be put in place to prevent further MSDs from occurring.

In order to better enable employers to capture such jobs, OSHA is setting a minimum frequency for job or task activities that must occur as a part of the screening tool. OSHA is setting this frequency at one day per week or more. Obviously, there are numerous values that could be chosen. However, OSHA believes that this value can reasonably be used to determine those job or task activities that are core element of an employee's job, and are foreseeable or reasonably predictable. In addition, a frequency of once a week or more is likely to capture many work activities that are an element of an employee's job that occur on a weekly basis (*e.g.,* deliveries or maintenance activities). To meet the screen, a job must ''routinely'' involve tasks that meet the designated criterion at least one day a week. This value will also provide guidance in that it can be used to rule out job or task activities that are rare occurrences, that are not predictable, or that result from unusual work circumstances.

In conclusion, in response to the comments received on the proposed standard, OSHA has developed a screening tool that will provide employers with quantitative guidance for determining work activities and conditions that are likely to cause or contribute to MSDs and that are a core element of a job or make up a significant amount of the employee's worktime. This screening tool includes specific descriptions of tasks and durations that will enable employers to evaluate jobs, quickly and consistently, at their worksites. To the extent possible, these descriptions and durations were developed using to the extent possible using the best available epidemiological literature as well as expert opinion from other groups who have developed very similar screening tools. This screen is intended to be used in conjunction with the event of an MSD incident to identify work conditions where exposure risks may exist such that a job analysis must be conducted to determine whether job controls are quickly and consistently necessary.

Paragraph (g)—What Actions Must I Take if the Employee's Job Meets the Action Trigger?

Paragraph (g) of the final rule defines the actions that employers must take if an employee with an MSD incident is employed in a job that meets or exceeds the action trigger. The paragraph requires that the employer must either implement the Quick Fix option in paragraph (o) of the final rule, or develop and implement an ergonomics program that includes the following elements:

(i) Management leadership as specified in paragraph (h) of this section;

(ii) Employee participation as specified in paragraph (i) of this section;

(iii) MSD management as specified by paragraphs (p), (q), (r), and (s) of this section;

(iv) Job hazard analysis as specified by paragraph (j) of this section;

(v) Hazard reduction and control measures as specified in paragraphs (k), (l), and (m) of this section, and evaluations as specified in paragraph (u) of this section, if the job hazard analysis determines that the job presents an MSD hazard;

(vi) Training as specified in paragraph (t) of this section.

A few commenters suggested that the effectiveness of ergonomics programs in reducing workplace MSD hazards was not demonstrated for the proposed rule. For example, the post hearing brief submitted on behalf of the U.S. Chamber of Commerce stated:

> None of this ''evidence'' * * * begins to support the proposition that an Ergonomics Program Standard such as the one contained in the Proposed Rule will reduce at all the incidence of workplace musculoskeletal complaints. [Ex. 500–188]

In contrast, the use of ergonomics programs as an effective method for addressing workplace MSD hazards was endorsed by the vast majority of commenters in the rulemaking record (see, *e.g.* Exs. 30–3855, 32–185, 500–209, Tr. 4940, Tr. 1491). For example, Mr. McCauseland, representing the American Meat Institute (AMI), testified during the rulemaking hearing: So what has happened in the 10 years since the meat packing guidelines were issued? Well, a number of things. In our industry, reduced levels of injuries and illnesses have been approximately one third of all incidents. Nearly one-half of lost time incidents have been reduced as well. * * * The guidelines have fostered proactive efforts to eliminate ergonomic risks and hazards in a wide ranging number of applications [Tr. 4940].

A complete discussion of the widespread support for the proposition that ergonomics programs are effective is contained in Chapter III of the Final Economic Analysis for the final rule. In that chapter, OSHA discusses the history of successful ergonomics programs and describes the extensive use of ergonomic programs throughout broad sectors of industry. In fact, the number, longevity, and extensive use of ergonomic programs that are similar to those required by OSHA's final rule clearly validate the Agency's regulatory approach, as well as demonstrating the inherent feasibility of the standard for covered employers who establish such programs.

Many of these programs have most or all of the program elements required by paragraph (g) of the final rule. The wide use of these elements in current programs is evidence that employers believe them to be essential, workable concepts. The program elements contained in the final rule are summarized and explained in other sections of this preamble and therefore will be discussed only briefly here in the context of the overall program requirement.

Paragraph (g) of the final rule specifies that if an employee's job exceeds the action trigger, the employer may implement a quick fix option for that job under paragraph (o). An employer who qualifies for the quick fix option does not need to establish an ergonomics program, although he or she must follow all of the quick fix procedures. However, if the employer cannot or does not implement a quick fix, then the standard requires an ergonomics program with the following elements:

- Management leadership,
- Employee participation,
- MSD management,
- Job hazard analysis,
- Hazard reduction and control,
- Training, and
- Evaluation.

Management leadership is critical to the successful implementation and operation of ergonomics programs.

Management leadership provides the focus and direction of the program's effort as well as the needed resources in terms of both personnel commitment and funding. The requirements for management leadership are described in the summary and explanation for paragraph (h).

Employee participation is equally important. Employees are essential sources of information about MSDs, risk factors, and MSD hazards in their work areas. They have valuable insights into effective control measures that can be used to reduce risk factors inherent in their jobs. The requirements for employee participation are described in the summary and explanation for paragraph (i).

MSD management provides for prompt and appropriate management when an employee has experienced an MSD incident. MSD management includes access to a health care professional, work restrictions as needed, work restriction protection, and evaluation and follow-up of the MSD incident. MSD management is important largely because it helps ensure that employees promptly report MSDs and signs and symptoms of MSDs. This, in turn, ensures that jobs that present MSD hazards will be included in the ergonomics program. The requirements for MSD management are described in the summary and explanation for paragraphs (p), (q), (r) and (s).

Job hazard analysis provides for the identification of the risk factors for jobs that meet the action trigger. The job hazard analysis provides a systematic approach to identifying and addressing the risk factors in the job. The requirements for job hazard analysis are described in the summary and explanation for paragraph (j).

Hazard reduction and control is the heart of the ergonomics program. Under this program element, employers control the risk factors in problem jobs identified during the job hazard analysis. The requirements for hazard reduction and control are described in the summary and explanation for paragraphs (k), (l), and (m).

Training provides employees with the information and understanding that they need to participate effectively in the ergonomics program. In addition, the training required by the final rule provides the more detailed information that supervisors, team leaders and other employees involved in setting up and managing ergonomics programs need to carry out their program-related responsibilities effectively. The training requirements are described in the summary and explanation for paragraph (t).

Evaluation is the process employers use to ensure that the program they have established is functioning as intended. Employers are required to evaluate their programs every three years and at other times if they have reason to beleive that the program is not functioning properly. The requirements for program evaluation are found in paragraph (a).

In summary, ergonomic programs similar to OSHA's in structure have been effectively reducing the incidence and/or the severity of MSDs for at least 10 years throughout the vast majority of general industry sectors. Model programs that contain OSHA's program elements have been implemented by a wide range of employers, such as large and small manufacturing establishments, utilities, and government agencies (see, *e.g.,* Exs. 32–185, 500–108, 38–50, Tr. 4693, Tr. 5696, Tr. 6310, Tr. 5931, Tr. 7031, Tr. 7068, Tr. 7074, Tr.7918, Tr. 7934, Tr. 7937, Tr. 7963, Tr.7948, Tr. 7999, Tr. 8826, Tr. 14707, Tr. 17350)

Paragraph (h)—Management Leadership

Paragraph (h) contains the final rule's requirements for management leadership. It requires that employers assign and communicate responsibilities for setting up and managing the ergonomics program; provide the authority, resources, and information necessary to meet those responsibilities; ensure that existing policies and practices encourage and do not discourage reporting and participation in the ergonomics program; and communicate periodically with employees about the program and their concerns about MSDs.

Paragraph (h) of the final rule is nearly identical in content to the proposed management leadership section (Section 1910.912). OSHA has elected to retain the management leadership requirements as proposed due to evidence in the record that supports the need for management commitment in any effective ergonomics program. Minor changes have been made to clarify the provision regarding the assignment and communication of responsibilities and to allow for more concise application of the subelement relating to the encouragement of reporting and participation.

OSHA proposed to require management leadership because the literature on ergonomics programs consistently cites management commitment as a vital component of an effective program (see, *e.g.,* Exs. 2–13, 26–2, 26–5, 26–9, 26–10, 26–13, 26–14, 26–17, 26–18, 26–22, 26–27). The need for management commitment was also supported by a number of responses to the ANPR (see, *e.g.,* Exs. 3–27, 3–124, 3–173).

The elements of the proposed and final management leadership requirements are based on the concept of management leadership expressed in the literature. OSHA considers the proposed and final management leadership provisions to be necessary to the exercise of leadership of the ergonomics program.

Responses to the proposed management leadership provisions indicated general support for the concept of management leadership. Comment on the provisions pertaining to the assignment and communication of responsibilities; provision of authority, resources, and information; and periodic communication focused on the interpretation, rather than the concept, and often criticized the proposal as vague. Comments regarding policies and practices that discourage reporting and participation revealed sharply divided opinion on the merits of the proposed provision.

The importance of management leadership as a component of an effective ergonomics program was supported in a number of comments on the proposed rule (see, *e.g.,* Exs. 30–2387, 30–3745, 30–3765, 32–78–1, 32–85–3, 32–182–1, 32–198–4, 32–339–1, 30–428, 30–3860, 30–4333, Tr. 3479, Tr. 3565, 32–450–1–18–1, Tr. 8004, Tr. 1496, Tr. 9070). David LeGrande of the Communications Workers of America, for example, when asked to indicate what characteristics distinguished successful ergonomics programs from those that fail, explained that the commitment of management is the primary factor in determining if a program will succeed (Tr. 9018).

The inclusion of a distinct requirement for management leadership in the proposed ergonomics standard, however, was considered by some parties to be inappropriate (see, *e.g.,* Exs. 32–78–1, 30–2830, 30–3853, 30–3765, 32–368–1, 500–223, 30–3426). Mandating the assignment of responsibilities and provision of authority, resources, and information, it was argued, is so vague as to lead to uneven enforcement by OSHA personnel, according to these commenters (see, *e.g.,* Exs. 30–74, 30–240, 30–1336, 30–3284, 30–3336, 30–3344, 30–3367, 30–3763, 30–3782, 30–3849, 30–3951, 30–4496, 30–4674, 30–4837, 30–4247). The Ameren Corporation, for example, stated:

> Whether an employer has committed enough ''resources'', has ''ensured'' that they have encouraged their employees to report or participate, or is communicating often

enough are all highly subjective judgement calls which cannot be consistently made by OSHA (Ex. 30–4247).

Bruno's Supermarkets and others (see, *e.g.,* Exs. 30–2836, 30–2837, 30–2828, 30–2839, 30–2840, 30–2841, 30–2842, 30–2843, 30–2844, 30–2940) concurred with this assessment, stating:

[The proposed standard] requires that employers communicate ''periodically'' with employees about the ergonomics program. Suppose, for example, that an employer distributes an annual ergonomics bulletin. How will the employer know whether an OSHA inspector will expect us to communicate more frequently, such as once a week or once a month? This section also requires employers to provide those managing the ergonomics program with ''resources,'' which are vaguely and broadly defined as ''the provisions necessary to develop, implement, and maintain an effective ergonomics program,'' including money, etc. We may feel that we have provided adequate resources necessary for such an effort, but we will have no way of knowing whether the OSHA inspector will agree. The lack of objective, attainable standards will leave employers at the whims of OSHA inspection personnel. (Ex. 30–2836)

The term ''periodically'' was specifically cited by a number of parties as being unduly subjective and open to interpretation (see, *e.g.*, Exs. 30–1101, 30–1336, 30–3826, 32–337–1, 30–1671, 30–3336, 30–3367, 30–3782, 30–4674, 30–3512). Some commenters said that determinations about the delegation of authority and assignment of resources were outside of OSHA's expertise and created excessive administrative burdens on employers (see, *e.g.*, Exs. 32–78–1, Tr. 12250). Such mandates were believed by some to be beyond the Agency's authority (see, *e.g.*, Exs. 30–2914, 30–4335).

OSHA has decided to retain a requirement for management leadership in the final rule. Management leadership is widely believed to be one of the core elements of any effective safety and health (including ergonomics) program. If no individuals in a given workplace have been assigned responsibilities for the ergonomics program, it is clearly unreasonable to expect that a successful program will somehow emerge. Likewise, if responsibilities are assigned but no authority is granted and no resources are provided, an ergonomics program is destined to fail. For example, if an individual is assigned responsibility for training workers in a problem job, that person needs access to relevant information about the MSD hazards and controls in the job, sufficient time to administer the training, and a suitable location for the training to take place. Communicating periodically with employees about the program and their concerns about MSDs is similarly essential to creating an environment where both the employer and employees are fully aware of issues relating to the ergonomics program. If a regular, two-way exchange does not take place, it would be impossible for employees to keep abreast of changes in the ergonomics program, or for the employer to receive feedback regarding the program. Without full knowledge, the benefits of the program will be diminished. The endorsement of management leadership in comments and the incorporation of this element in successful ergonomics programs supports OSHA's conviction that management leadership is a critical component of an ergonomics program.

Those who expressed the sentiment that the management leadership requirements of the proposal were vague or burdensome appeared to believe that OSHA compliance personnel would arbitrarily decide if the authority, resources, and information provided were satisfactory, or if the frequency of communication was adequate. OSHA reaffirms its belief, expressed in the proposal, that employers should retain broad discretion in deciding who should bear responsibility for the various components of the ergonomics program, and what authority, resources, and information are necessary and appropriate to meet the assigned responsibilities in a given workplace.

The frequency of communication with employees is also subject to wide latitude in order to account for the needs of different workplaces. The term ''periodically'' is used in the standard to indicate that communication must be performed on a regular basis that is appropriate for the conditions in the workplace. A rigid schedule, however, is not specified, in order to provide flexibility to account for the circumstances found in different workplaces and even at different times in the same workplace. Additional discussion of this topic can be found in the section of this preamble devoted to additional statutory issues (see Section XII of the preamble).

The general requirements in paragraph (h) of the final rule for the assignment of responsibilities and provision of authority, resources and information are designed to complement the more specific requirements for action found elsewhere in the standard. For instance, under paragraph (i) of this final rule, employees must receive prompt responses to reports of MSDs. It is the duty of the employer to assign the responsibility for providing those responses and to provide the necessary authority, resources, and information needed to do so. If a prompt, correct response is given to the employee, then the employer's assignment of responsibility and provision of authority, resources, and information will clearly have been satisfactory.

The final rule does not describe how responsibility is to be allocated or how individuals will be held accountable for their responsibilities. This is to allow employers the greatest possible flexibility in adapting the program to their particular situation. A concern was registered that the proposed requirement for assigning responsibility would conflict with a management structure that did not include supervisors (see, *e.g.*, Ex. 30–3765). OSHA does not intend to prescribe what program responsibilities are vested in any party. An employer may choose to designate and empower front line employees with any responsibility associated with the program, so long as the authority, resources, and information necessary to meet those responsibilities are provided.

The role that contractors, consultants, and other outside parties may play in an ergonomics program has also been recognized by the Agency. Although not required by the standard, OSHA is aware that outside expertise may be beneficial in some instances. Accordingly, the final rule allows the employer to chose who is designated with regard to the assignment of responsibility. Ergonomists, safety professionals, industrial hygienists, and others may be involved in the employer's program.

Several commenters suggested that OSHA place requirements on employees as well as employers in the final rule (see, *e.g.*, Exs. 30–3765, 30–584, 30–3368). These commenters believe that employees must take responsibility for their actions. OSHA agrees that active employee involvement in the ergonomics program is essential to program effectiveness but does not believe that this principle should be stated in the standard, for a number of reasons. First, the OSH Act itself, at Section 5(b), states that ''Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to the OSH Act which are applicable to his own actions and conduct.'' However, the courts have repeatedly held that employers are responsible under Section 5(a)(2) of the Act for ensuring worker protection. For example, the court in *Brock* v. *City Oil Well Service Co.,* 795 F. 2d 507, 511 (5th Cir. 1986) held, ''it is the employer's responsibility to ensure that the employees are protected. It may accomplish this objective through others if it chooses, but the duty to provide the protection remains the employer's.'' If, for example, an employer has determined that lifting an 80-pound box poses an MSD hazard to employees, the employer can establish a policy of requiring employees to use a mechanical lift to raise such a box and train employees how to do this. The employer could then hold the employee accountable for adhering to this policy in the same manner as other policies or rules are enforced.

In addition to providing authority, resources, and information, the proposed management leadership section included a requirement to provide the training necessary to meet assigned responsibilities. Because training for those responsible for setting up and managing the program is addressed in paragraph (t) of this final rule, training has been deleted from this paragraph in order to avoid potential confusion.

Some commenters expressed the belief that management leadership is implicit in an effective ergonomics program, and an independent requirement for management leadership is therefore unwarranted (see, *e.g.*, Exs. 30–3765, 30–1293). Dow Chemical, for example, while strongly supporting the need for management leadership in safety and health activities, expressed the view that it is not appropriate for OSHA to attempt to regulate and enforce leadership. By establishing and evaluating the effectiveness of an ergonomics program, Dow argued, the employer has in effect demonstrated leadership (Ex. 30–3765).

In a similar vein, some parties argued that the requirements for management leadership were largely redundant with other sections of the proposal. They pointed out, for example, that communicating periodically with employees about the ergonomics program and their concerns about MSDs was part of the proposed management leadership provision, while separate, specific requirements for communication with employees were proposed as part of the provisions pertaining to quick fix, employee participation, hazard information and reporting, job hazard analysis and control, training, MSD management, and program evaluation. This ''duplication,'' it was argued, could subject employers to being cited twice for a single violation (see, *e.g.*, Exs. 30–3344, 30–4674).

OSHA believes that there is little, if any, overlap with other parts of this standard. The management leadership and employee participation elements of the final rule should be considered the overall conceptual foundation of an effective ergonomics program and a vital part of the organizational framework of an effective program. By fully understanding the importance of management leadership and employee participation, it is expected that program managers will determine how best to apply these concepts in a particular workplace and how the individual subelements will work most efficiently in their environment. Even where some overlap could be perceived, it is not OSHA's policy to issue duplicate citations for a single violation.

The management leadership element also includes requirements unique to this paragraph, such as the requirement in paragraph (h)(3). That requirement specifies that the employer must ensure that their policies and practices encourage and do not discourage reporting or participation in the program. OSHA believes that applying this provision in an ergonomics program is a logical component of management's effort to direct the ergonomics program in a manner that will be protective of employee health.

OSHA's proposed requirement for employers to ensure that their existing policies and practices encourage and do not discourage reporting and participation in the ergonomics program elicited a substantial volume of comment. As explained in the preamble of the proposal, this proposed provision was intended to encourage the early reporting of MSDs and meaningful employee participation in the ergonomics program. OSHA believes that employees in all workplaces should be encouraged by their employers to report injuries, illnesses, and hazards of all kinds—not just those related to ergonomic issues—because only full and frank reporting allows employers to identify hazards and do something about them.

Particular attention was paid by participants regarding the requirement that employers ensure that their policies and practices do not discourage reporting and participation in the program, and the effect of this provision on existing employer programs, including safety incentive programs and employee drug testing programs.

Policies and practices given in the preamble to the proposal as examples of those that may discourage reporting included:

- Programs that reward or punish employees on the basis of injury or illness reports by offering incentives or awards based on low numbers or rates of reported MSDs.
- Policies that require every employee reporting an MSD or MSD signs and symptoms to submit to a drug or alcohol test.
- Direct or reasonably perceived threats of retaliation, including firing or suspension, withholding overtime work for anyone who reports MSD signs or symptoms, (even from jobs that do not involve exposure to risk factors), prohibiting the use of sick leave for a work-related injury; and sending every employee who reports MSD signs and symptoms home without pay.

Expressed or implied warnings of retaliation for reporting MSDs, MSD signs and symptoms, or MSD hazards would clearly be considered a practice that would discourage reporting. If, for example, a supervisor were to inform employees working the day shift that reporting MSD signs and symptoms would automatically result in transfer to the night shift, this action could be reasonably anticipated to suppress reporting. An example of a situation similar to this was described by the UFCW. The union explained that employees were reluctant to report injuries in this situation due to the consequences they would face:

> [The company] had established a special ''C'' shift—the graveyard shift—for employees suffering from work-related injuries, many of which were cumulative trauma disorders. The purported purpose of the C shift crew was to assist injured workers with long term medical restrictions in returning to regular duty. In fact, however, a number of employees assigned to the crew were taken off regular duty jobs which they had been performing successfully with their restrictions. They were then isolated and segregated on the C shift and assigned degrading, demeaning, make-work tasks such as picking up cigarette butts in the parking lot at night with flashlights or scraping rust off of pipes in the rendering department (Ex. 32–210–2).

Some employers have taken this a step further, pursuing policies that discipline workers for reporting injuries, without considering the cause of those injuries. When rewards or punishment are linked to the reporting of MSDs or MSD signs and symptoms, employee reporting behavior can clearly be influenced. Punishment for reporting in the form of wage reductions, loss of overtime, reprimands, suspensions, or other means can be expected to discourage reporting.

An example of this approach is a system of imposing progressively more severe penalties when injuries are reported, such as a written reprimand for the first incident, followed by suspension, and finally termination (see, *e.g.*, Exs. 32–298–2). Another example is a system that assigns a point value to an incident based on factors such as the cost of the incident to the employer or whether lost workdays were involved. Progressive levels of punishment are meted out based upon the number of points that an employee accumulates (see, *e.g.*, Ex. 500–111–1). Kathy Saumier of the United Steelworkers described such a program and its results in the plastics plant where she worked:

The company had a policy to give out points if an employee missed work even due to work related injury. After an employee accumulated seven points, the company reduced the employees' pay by 50 cents per hour. If the employee accumulated 15 points an employee was then terminated. This system caused many workers to go to work injured for fear of pay reduction or termination (Tr. 10992).

The record also included many instances where, intentionally or inadvertently, employer policies and practices were said to discourage employees from reporting MSDs (see, *e.g.*, Exs. 20–626, 32–111–4, 32–198–4–1, 32–198–4–2, 32–210–2, 32–298–2, Tr. 5598, Tr. 6980, Tr. 7715, Tr. 7729, Tr. 7387, Tr. 7730, Tr. 8041, Tr. 10153, Tr. 10230, Tr. 10763, Tr. 13870, Tr. 14535, Tr. 15131, Tr. 15453, Tr. 16766).

Incentive programs that offer rewards to employees or groups of employees based on a low number of reported injuries were also mentioned as factors inhibiting the reporting of MSDs. Bill Byington of the IBT described how employees in his workplace were being taken to a baseball game for completing a month of work without a reported injury; he was aware, however, that at least one of the members of the group had sustained an injury and not reported it (Tr. 15453). Sandy Brooks of the United Steelworkers related her experience with a ''safety bingo'' program, where employees receive a bingo number each day, and the employee who wins the bingo game receives cash, weekend trips, and dinners as prizes. The bingo game ends for all employees, however, when an OSHA recordable injury is reported. Ms. Brooks was also aware of workers who did not report injuries because of the incentive program (Tr. 7703).

An additional factor in group incentive programs that can serve to coerce employees to refrain from reporting MSDs is the peer pressure that can be exerted when group awards are at stake. Joe Enos of the UAW described the result of an incentive program that offered a microwave oven to a team of workers if they reduced reported injuries 25% from the previous year:

The group had achieved that goal going into November and they still had a month to go. And one of the workers got hurt. And the rest of his coworkers told him, ''Hey, you go to medical, there goes the microwave.'' And this guy realized that his health was more important than some microwave. But a good many of his coworkers wouldn't even talk to him for a couple of weeks as a result of that (Tr. 15453).

Dr. Richard Bunch of the Industrial Safety and Rehabilitation Institute told of an injury sustained but not reported early, in order to preserve workers' chances of winning a barbeque pit:

One company was giving a barbeque pit as a prize if you went so many months without reporting an injury. And one gentleman had a back problem and did not report it because the other six members on his team threatened him with violence. So in that case, he did not report it, but ended up going to a full blown frank rupture of the disc (Tr. 11638).

These accounts of individuals support the impression that incentive programs that tie rewards or punishment to the report of an injury may result in reductions in reported injuries and illnesses, at least in part due to lack of reporting rather than an actual reduction in the number of injuries that occur. Nancy Lessin of the Massachusetts AFL–CIO espoused this view:

Workers can not control the conditions which lead to most work-related injuries and illnesses. They can control whether or not they report an injury or illness. Safety incentive programs manipulate the thing workers can control—the reporting of workplace injuries and illnesses * * * (Ex. 32–298–2).

The United Steelworkers concurred with that assessment:

We know better than to believe that worker behavior is the primary cause of most workplace accidents. We know that exposure to workplace hazards causes injuries and illness and exposure to ergonomic hazards causes MSDs. Ergonomic hazards need to be controlled to eliminate MSDs in the same manner that we address any workplace hazard. Incentive programs based on injury rates, and behavior-based safety programs do not correct hazards. In fact, these programs can make a bad situation worse by diverting attention from correctable hazards, and promoting the under reporting of injuries (Ex. 32–111–4).

Several commenters argued that OSHA had not made a determination that incentive programs result in the underreporting of MSDs (see, *e.g.*, Exs. 30–4185, 30–1070, 30–3347, 30–4185). The Synthetic Organic Chemical Manufacturers Association suggested that OSHA obtain data to support its position, stating:

If OSHA believes that employers are not properly reporting injuries and illnesses, it should address this issue by gathering the data to substantiate its position. OSHA should not discourage employers from utilizing all necessary injury/illness prevention tools. There is no basis for the proposed Ergonomics Standard to suggest that these effective programs should be subject to further scrutiny (Ex. 30–3843).

Sufficient evidence has already been entered in the record, however, for OSHA to reach the conclusion that MSDs are substantially underreported (see the discussion of underreporting in the Significance of Risk section of this preamble as well as the Benefits chapter of the Final Economic Analysis). Evidence also supports the belief that employer policies and practices often contribute to this underreporting by discouraging the reporting of MSDs.

A review of the literature on safety incentives commissioned by OSHA and published in 1998 divided incentive programs into two categories based on the behavior they reward. The review found that the literature strongly indicates that programs that measure safe work practices, such as wearing safety glasses for eye protection or using a seat belt when driving, may increase the frequency of such practices. The literature review further disclosed that incentive programs that focus on reductions in the number of injuries and illnesses reported do not improve safety practices. No scientific studies were found indicating that such programs had either a positive or a negative impact (Ex. 502–281).

Some policies and practices can affect employee participation in the ergonomics program, as well as employees' incentive to report. Employees who are punished or discouraged from reporting MSDs or MSD signs and symptoms, may also feel discouraged from participating in any meetings or discussions about ergonomic problems in the workplace and how to address them. If a worker is threatened with retaliation for pointing out hazards or for participating in a job hazard analysis, that worker and his or her co-workers are unlikely to take part in this activity or future activities. Employees are likely to be discouraged from requesting information to which they may be entitled, such as training materials or information about this standard, if they fear retaliation or if obtaining the information is made inconvenient. Likewise, if employees in a problem job are asked for recommendations about eliminating or controlling MSD hazards, but are required to attend a meeting at an unreasonable time in an inconvenient place, or that may involve loss of pay in order to submit those recommendations, the likelihood of those employees participating in the process would be diminished.

Some commenters were concerned that a wide variety of employer policies and practices could have the potential to impact employee participation and reporting of injuries; even a review of a manager's or supervisor's performance could be found to constitute a violation of the standard when performance criteria in that review include the number of injuries and illnesses recorded by employees under his or her supervision (Ex. 30–4185).

OSHA is concerned with the effect of a policy on employees' participation in the ergonomics program and whether the program or policy discourages reporting. In some cases, making the number of injuries and illnesses recorded a part of a manager's performance review can result in a policy the discourages reporting. Larry Hall of the United Food and Commercial Workers described such a situation.

> One of the things that happens with the [manager] bonuses is the worker reports a problem, and the manager immediately tells them how that is going to affect their bonus. If you are working for me and I say, "Gee, that is going to really affect my bonus. So, for the rest of your life, you get to work nights," these people write their schedules. They control their lives. If you are going to displease me and take money out of my pocket, I can really do a lot to you and stay within the union contract. (Tr 14538)

OSHA finds that the evidence strongly demonstrates that employer policies and practices that reward non-reporting and punish, threaten, or otherwise discourage employee reporting of MSD incidents have the effect, in many instances, of suppressing incident reports. This conclusion is based on the strong record presented by witnesses and documentary submissions as well as on the logic that providing incentives to not report accidents or illnesses is likely to reduce the number of such reports, but unless the cause of those incidents is addressed, it is unreasonable to believe that MSD incidents themselves will be reduced in number. The litany of case reports in the record where employer policies and practices were said to deter reporting reinforce this position. The concealment of MSD incidents would in fact have an effect directly opposed to the purpose of this standard. Hazards that would otherwise be identified and eliminated or controlled would remain and continue to threaten employees. MSD incidents that, if reported, could be limited in severity through rest or treatment would instead be allowed to progress.

In contrast to the comments describing the pressures on employees not to report MSDs, a number of parties were concerned that the proposed prohibition on policies or practices could inadvertently eliminate widely accepted, sensible, and successful safety practices. Many commenters indicated concern that the proposed prohibition on policies or practices that discourage worker reporting could be interpreted to eliminate demonstrably successful employee incentive programs (see, *e.g.*, Exs. 30–3765, 32–368–1, 30–656, 30–1048, 30–1070, 30–1349, 30–1551, 30–1567, 30–1616, 30–1652, 30–1671, 30–1901, 30–2038, 30–2050, 30–2061, 30–2499, 30–2514, 30–2799, 30–2811, 30–2812, 30–2814, 30–2815, 30–2846, 30–2988, 30–2990, 30–3086, 30–3174, 30–3177, 30–3336, 30–3349, 30–3353, 30–3354, 30–3678, 30–3721, 30–3736, 30–3745, 30–3819, 30–3848, 30–3951, 30–4122, 30–4185, 30–4334, 30–4496, 30–4540, 30–4607, 30–4674, 30–4702, 30–4818, 30–4822, 30–4839, 30–4843, 31–310, 32–21–1, 32–82–1, 32–120–1, Tr. 10445, Tr. 11502, Tr. 12857, Tr. 16924, Tr. 17461, Tr. 17483, 30–4340, 500–1–28, 500–1–29, 500–1–42, 500–1–69, 500–1–70, 500–1–79, 500–1–86, 500–1–95, 500–1–106, 500–1–112, 500–1–113, 500–1–114, 500–1–136, 500–1–147, 500–1–181, 500–1–117, 500–1–119, 500–1–121, 500–1–124, 500–1–125, 500–1–127, 500–1–135, 500–1–137, 500–1–152, 500–1–193, 500–1–442, 32–258–2, 30–911, 30–1942, 30–3236, 30–3339, 500–219, 601–x–1710, 601–x–1711, 30–4527, 30–980, 30–2668, 30–4565, 30–3847, 30–2684, L30–4985, 30–4029, 30–4335, 30–4443, 30–1004, 30–1010, 30–1017, 30–1025, 30–1027, 30–1035, 30–1038, 30–1042, 30–1044, 30–1045, 30–1079, 30–1080, 30–1089, 30–1099, 30–1163, 30–1164, 30–1401, 30–1403, 30–1423, 30–1424, 30–1436, 30–1440, 30–1455, 30–1460, 30–1463, 30–1495, 30–1497, 30–1566, 30–1658, 30–1659, 30–1674, 30–1675, 30–1682, 30–1684, 30–1685, 30–1686, 30–1687, 30–1688, 30–1689, 30–1690, 30–1691, 30–1916, 30–2124, 30–2126, 30–2234, 30–2235, 30–2236, 30–2237, 30–2275, 30–2279, 30–2311, 30–2369, 30–2376, 30–2588, 30–2673, 30–2674, 30–2768, 30–2850, 30–2925, 30–3002, 30–3042, 30–3044, 30–3080, 30–3083, 30–3087, 30–3229, 30–3380, 30–344, 30–346, 30–3822, 30–3985, 30–3988, 30–4037, 30–4059, 30–4507, 30–4770, 30–4841, 30–5044, 30–5106, 30–634, 30–636, 30–638, 30–643, 30–649, 30–871, 30–883, 30–891, 30–903, 30–905, 30–918, 30–978, 30–994, 30–995, 600–x–10, 600–x–11, 600–x–12, 600–x–13, 600–x–45, 600–x–46, 600–x–5, 600–x–6, 600–x–7, 600–x–9, 601–x–1358, 601–x–1363, 601–x–1364, 601–x–1365, 601–x–1366, 601–x–1367, 30–1416, 30–1453, 30–1457, 30–1616, 30–1998, 30–1999, 30–2131, 30–2142, 30–2184, 30–2233, 30–2250, 30–2304, 30–2395, 30–2396, 30–2423, 30–2431, 30–2736, 30–2829, 30–2889, 30–2891, 30–2992, 30–3003, 30–3254, 30–3334, 30–3393, 30–3551, 30–3597, 30–3791, 30–3882, 30–3936, 30–3944, 30–3974, 30–3977, 30–3999, 30–4464, 30–4532, 30–4539, 30–4544, 30–4629, 30–4657, 30–4667, 30–4669, 30–4980, 30–5034, 30–5076, 30–5095, 30–5101, L30–4952, L30–4953, L30–5096).

Caterpillar Inc., for instance, attested to the favorable impact of incentive programs in that firm:

> Incentive programs have always been an excellent vehicle to raise awareness, communicate various issues throughout the workplace and show employer concern about employee safety. While OSHA considers these programs to be disincentives [to the reporting of MSDs and MSD signs and symptoms], our experience shows that they have positive benefits. By increasing awareness and rewarding safe behaviors through incentive programs, employers have seen a reduction in all injury categories (Ex. 30–4607).

Nothing in this final rule would prohibit incentive or award programs. The obligation that an employer would have, should they chose to adopt an incentive program, would be to ensure that the incentive program did not discourage the reporting of MSDs, MSD signs and symptoms, or MSD hazards, or discourage participation in the ergonomics program. As explained previously, OSHA's concern is that discouraging full reporting and participation in the ergonomics program will diminish the effectiveness of the program.

Although incentive programs that are successful in promoting workplace safety can be expected to result in a reduction in the number of injuries reported, an unsuccessful program that does not improve workplace safety can also result in fewer reported injuries. When the yardstick for measuring the success of the program is only the number of injuries reported, the program can distort the true state of affairs and preclude early intervention by inducing employees to avoid reporting their injuries. This problem is particularly critical with regard to MSD signs and symptoms, where early intervention can be of great importance. OSHA encourages employers to focus any incentives on safe work practices, active participation in safety programs, and identification of hazards in the workplace. By doing so, the root causes of injuries and illnesses can be addressed, and a safer workplace can be created. The Incentive Federation described the types of activities that a safety incentive program can target, rather than using the number or rate of reported injuries as its objective:

* * * a good safety incentive program often focuses on proactive behavior. For example, it might encourage employees to make safety suggestions, attend safety meetings, promote safety awareness, participate in safety inspections, report safe behavior, report near misses, and so forth. In addition, self-directed safety teams, where employees observe each other at work and report good and bad safety conduct (without necessarily using the names of the specific employees), encourage safe behavior. Encouraging this type of employee participation is extremely useful, because employees are reasonably objective in observing their peers, and they report good and bad behavior. The conduct observed can then be included in periodic reports or reviewed in safety meetings to stress safe behavior. (Ex. 30–1100).

Drug testing programs, when applied to all workers who report MSDs, were also said to hinder full reporting of injuries. Chuck Monohan of the International Brotherhood of Electrical Workers explained that a fear of false positive results was responsible for non-reporting (Tr. 7378). Other commenters also discussed the chilling effect that drug testing programs can have on reporting injuries (Tr. 5997, Tr. 13869, Tr. 17509)

A large number of commenters expressed concern that the proposed prohibition on policies or practices that discourage worker reporting could be interpreted to eliminate widely accepted drug testing policies (see, *e.g.,* Exs. 30–536, 30–2208, 32–368–1, 30–3765, 30–419, 30–519, 30–1012, 30–1048, 30–1070, 30–1261, 30–1332, 30–1348, 30–1349, 30–1358, 30–1536, 30–1551, 30–1567, 30–1616, 30–1652, 30–1671, 30–1901, 30–2050, 30–2061, 30–2499, 30–2514, 30–2645, 30–2675, 30–2799, 30–2811, 30–2812, 30–2814, 30–2815, 30–2988, 30–2990, 30–3174, 30–3177, 30–3348, 30–3349, 30–3353, 30–3356, 30–3359, 30–3721, 30–3723, 30–3736, 30–3745, 30–3819, 30–3951, 30–4046, 30–4122, 30–4567, 30–4607, 30–4628, 30–4674, 30–4702, 30–4713, 30–4818, 30–4822, 30–4839, 30–4844, 31–282, 31–298, 31–310, 32–335, Tr. 4335, Tr. 4909, Tr. 6112, Tr. 8350, Tr. 9190, Tr. 10444, Tr. 12857, Tr. 12958, Tr. 15621, Tr. 15644, Tr. 15976, Tr. 17461, Tr. 17483, 30–3725, 30–4340, 30–4146, 500–1–28, 500–1–42, 500–1–69, 500–1–70, 500–1–79, 500–1–86, 500–1–95, 500–1–106, 500–1–112, 500–1–113, 500–1–114, 500–1–136, 500–1–140, 500–1–147, 500–1–181, 500–1–185, 500–1–117, 500–1–119, 500–1–121, 500–1–124, 500–1–125, 500–1–127, 500–1–135, 500–1–137, 500–1–152, 500–1–193, 500–1–411, 500–1–384, 500–1–385, 500–1–386, 500–1–413, 500–1–423, 500–1–442, 500–16, 500–52, 500–23–1, 32–258–2, 30–904, 30–911, 30–1942, 30–3236, 30–3339, 500–219, 30–4550, 601–x–1711, 30–1363, 30–4248, 30–4778, 30–2455, 30–4527, 30–2668, 30–4565, 30–3847, 30–2684, L30–4985, 30–3472, 30–3582, 30–4029, 30–4335, 30–4443, 30–4475, 30–4528, 30–4688, 30–1004, 30–1010, 30–1017, 30–1025, 30–1027, 30–1035, 30–1038, 30–1042, 30–1044, 30–1045, 30–1079, 30–1080, 30–1089, 30–1099, 30–1163, 30–1164, 30–1401, 30–1403, 30–1423, 30–1424, 30–1436, 30–1440, 30–1455, 30–1460, 30–1463, 30–1495, 30–1497, 30–1566, 30–1658, 30–1659, 30–1674, 30–1675, 30–1682, 30–1684, 30–1685, 30–1686, 30–1687, 30–1688, 30–1689, 30–1690, 30–1691, 30–1916, 30–2124, 30–2126, 30–2234, 30–2235, 30–2236, 30–2237, 30–2275, 30–2279, 30–2311, 30–2369, 30–2376, 30–2588, 30–2673, 30–2674, 30–2768, 30–2850, 30–2925, 30–3002, 30–3042, 30–3044, 30–3080, 30–3083, 30–3087, 30–3229, 30–3380, 30–344, 30–346, 30–3822, 30–3985, 30–3988, 30–4037, 30–4059, 30–4507, 30–4770, 30–4841, 30–5044, 30–5106, 30–634, 30–636, 30–638, 30–643, 30–649, 30–871, 30–883, 30–891, 30–903, 30–905, 30–918, 30–978, 30–994, 30–995, 600–x–10, 600–x–11, 600–x–12, 600–x–13, 600–x–45, 600–x–46, 600–x–5, 600–x–6, 600–x–7, 600–x–9, 601–x–1358, 601–x–1363, 601–x–1364, 601–x–1365, 601–x–1366, 601–x–1367, 30–2410, 30–2289, 30–3877, 30–2601, 30–3160, 30–3598, 30–2912, 30–1332, L30–5025, 30–4280, 30–1416, 30–1453, 30–1457, 30–1616, 30–1998, 30–1999, 30–2131, 30–2142, 30–2184, 30–2233, 30–2250, 30–2304, 30–2395, 30–2396, 30–2423, 30–2431, 30–2736, 30–2829, 30–2889, 30–2891, 30–2992, 30–3003, 30–3254, 30–3334, 30–3393, 30–3551, 30–3597, 30–3791, 30–3882, 30–3936, 30–3944, 30–3974, 30–3977, 30–3999, 30–4464, 30–4532, 30–4539, 30–4544, 30–4629, 30–4657, 30–4667, 30–4669, 30–4980, 30–5034, 30–5076, 30–5095, 30–5101, L30–4952, L30–4953, L30–5096).

The sentiment that the contribution of drug-testing programs to workplace safety should not be compromised by the requirements of the ergonomics standard was expressed by Food Distributors International:

In the view of FDI and its members, the possibility that some individuals will feel constrained to avoid reporting workplace injuries or accidents because of a drug test requirement that might be triggered is not an overriding concern. These fears largely will relate only to those whose drug use may be discovered, and their protection should not be the goal of a major OSHA regulatory scheme. In addition, any such inhibiting effect is more than outweighed by the workplace accidents and injuries that are avoided through maintenance of an effective drug-free workplace program (Ex. 30–3819)

OSHA is not aware of any basis for concluding that the development of MSDs is in any way associated with the use of drugs or alcohol. The reporting of MSDs or MSD signs and symptoms covered under this rule, therefore, cannot be considered by itself to provide any justification for testing. Although subjecting all parties reporting injuries or all OSHA recordable cases to testing has sometimes been used by employers as a matter of administrative convenience in identifying individuals for testing, the lack of a relationship between drug or alcohol use and the MSDs covered by this rule, along with the detrimental effect on reporting behavior that testing can have, combine to make this an inappropriate practice where MSDs are concerned.

Furthermore, there is no evidence that drug tests discourage workers from reporting injuries only if they fear that drug use will be discovered. Adrienne Markowitz of the UFCW described a poultry processing plant where workers who reported pain in the hands and wrists were required to be tested for illegal drugs:

This is a church going and religious community. Most people were not worried that drugs would be found because they didn't take them. But they weren't happy with having to suffer the indignities of having someone watch them urinate, were afraid that inaccurate testing and laboratory practices [would erroneously indicate illegal drug use], were concerned that the medications they took would show up as illegal drugs, and [were] fearful that the company supervisors would doctor the records. Many, for the reasons I have just stated, refused to take the test and were fired. And many others just never reported their illnesses (Tr. 5998).

This rule does not in any way prevent an employer from conducting testing if it is required by law, is based on reasonable suspicion, is part of the job application process, is part of routine fitness-for duty examination, is done as follow-up after entering an employee assistance or drug rehabilitation program, or is administered to assist in post-accident investigation. A blanket policy that requires all employees reporting MSDs or signs and symptoms of MSDs to submit to drug or alcohol testing, however, would hinder the effectiveness of the ergonomics program if such a policy results in underreporting.

Nor is the fear that a back injury or other MSD may be the result of an accident caused by drug or alcohol use a reason for testing employees for drugs when reporting an MSD or MSD signs or symptoms. As stated in paragraph (a), this standard does not address injuries caused by slips, trips, falls, vehicle accidents, or other similar accidents. The standard addresses injuries that are the result of exposure to force, repetition, awkward postures, vibration, and contact stress. Injuries covered by the standard are commonly associated with prolonged or excessive exposures to these ergonomic risk factors. There is no reason to believe that drugs or alcohol have any relevance to the development of these conditions and certainly no evidence that impairment at the time of reporting has any relevance. Simply reporting MSD signs and symptoms therefore cannot be viewed as a legitimate reason to suspect drug or alcohol abuse.

Some commenters argued that if an ergonomics standard did restrict drug testing programs, this could conflict with regulatory requirements of the Department of Transportation or Nuclear Regulatory Commission, or with policies established through collective bargaining (see, *e.g.,* Exs. 30–3853, 30–3765, 30–1070, 30–1332, 30–1671, 30–3284, 30–3359, 32–335, Tr. 15621, 500–1–28, 30–4527, 30–4029, 30–4475, 30–4248). Restrictions on drug testing were also said to conflict with requirements for companies with government contracts (see, *e.g.,* Exs. 601–x–1711, 30–4475).

Language in the proposal that could affect certain employer drug testing policies was said to conflict with state workers' compensation laws, and thus violate Section 4(b)(4) of the Occupational Safety and Health Act. State workers' compensation laws, it was said, may require drug testing in certain instances, allow reduced insurance premiums for those employers with testing programs, or allow impairment to be used as a defense in contesting compensation claims (see, *e.g.,* Exs. 500–104, 500–104–1).

It was argued that restrictions on drug testing programs could result in liability claims against those employers whose employees acted in an unsafe manner due to impairment. The New Mexico Self Insurers Fund stated:

> OSHA may have had the best intentions when writing the preamble, however if state and local government municipal employers were to neglect the possibility that alcohol and drug use was a factor in an injury, whether or not it is an MSD, municipal liability would rise exponentially. The bottom line is that many local governments would not be immune from lawsuits where gross negligence is alleged. It would be easy to show negligence on the part of a local government that allowed ''waivers'' of its alcohol and drug testing ordinances for employees in order to permit full and free reporting of MSDs (Ex. 30–4810).

OSHA's concern is that testing not be conducted in a manner that penalizes individuals reporting MSDs or participating in ergonomics programs. This final rule does not restrict employers' drug or alcohol testing policies where such policies are authorized by state or federal law. It should be noted, however, that DOT regulations, which require post accident testing and testing of safety sensitive employees and under certain other circumstances, do not require drug testing when MSDs or any other type of injury or illness is reported.

Workers compensation and other state and federal laws that require drug testing following a traffic or other accident, are also not generally relevant to the application of this standard, because as explained above, MSDs resulting from accidents, slips, trips and falls are specifically exempted from this rule.

A number of employee representatives expressed the opinion that policies or practices that can discourage worker participation in the ergonomics program, such as incentive programs and post-injury drug testing, should be explicitly prohibited in the rule (see, *e.g.,* Exs. 32–339–1, 32–111–4, 32–198–4, 32–210–2, 500–50). Absent such a prohibition, it was argued, an ergonomics standard triggered by employee reports of injury would be undermined by employers who would pressure employees to avoid reporting injuries. These commenters argued that the case-by-case determination approach described in the preamble to the proposal would be inadequate to deter practices that discourage participation and reporting, and a blanket prohibition in the rule itself is necessary.

Some parties indicated that they did not find the proposal sufficiently clear in indicating what policies or practices would be considered by OSHA to discourage worker participation in the ergonomics program (see, *e.g.,* Exs. 30–3853, 30–4185, 32–337–1, 30–653, 30–1350, 30–2216, 30–3233, 30–3344, 32–82–1, 30–1101, 500–33). Concern was expressed that compliance would be dependent upon whether or not employees feel discouraged, and would thus be determined by the subjective perceptions of employees (see, *e.g.,* Ex. 30–3853, 30–4247, 500–33, 32–266–1). TXU Business Services, for example, stated:

> Any regulation that has provisions for employees ''not feeling discouraged'' would be impossible to enforce fairly. For example, identical employer conduct could be legal in one plant, or part of a plant, and illegal in another and the employer might never know it (Ex. 500–1–28).

In order to provide an objective basis for enforcement of this provision, OSHA has concluded that a pattern of underreporting must be evident in the workplace before a determination will be made that any given employer policy or practice discourages reporting of MSDs or signs and symptoms of MSDs. If underreporting or discouragement of employee participation in the ergonomics program is found at a particular establishment as a result of a records review or employee interviews, OSHA will evaluate the situation to determine if employer policies and practices have had the effect of discouraging reporting or participation in the ergonomics program. OSHA's position is that these policies and procedures are not per se illegal, but they can clearly discourage reporting and participation. If an employer has policies or procedures with this potential, the employer must ensure that these policies and procedures are not actually discouraging reporting or participation.

OSHA expects that employers will have ample opportunity to discover whether employees are being discouraged through the periodic communication that will take place under the standard. If policies and practices are determined to discourage reporting or participation, employers would need to take action to remedy this situation.

OSHA considers it important that the employer not only not discourage, but actively encourage reporting and participation in the ergonomics program. The Agency believes that this goal can be accomplished by providing information to employees about the importance of early reporting in accordance with paragraph (d), along with effective training on reporting and the ergonomics program in accordance with paragraph (t) of this final rule.

Several parties asked whether the proposed prohibition on policies or practices that discourage reporting would apply to an employer's decision as to whether or not an employee can work overtime (see, *e.g.,* Exs. 32–368–1, 30–2208, 30–3765, 30–1671, 30–2050, 30–2499, 30–3344, 30–3348, 30–3356, 30–4628, 30–4674, 500–1–140). Withholding overtime, it was argued, may be based on a desire to prevent aggravation of the potential MSD, and limiting the employer's ability to restrict overtime would thus conflict with provisions in the proposed standard that allow employers to use administrative controls (Ex. 30–1671). The Association of Independent Corrugated Converters stated:

> While some employers do not choose to impose such restrictions, it seems unfathomable that involuntary restrictions on some overtime work would be deemed an inappropriate management step, both before and after symptoms reported by employees are analyzed by a health care provider. The essence of some MSDs, at least in OSHA's own construct of such conditions, is that overuse in the form of ''excessive'' repeated exposure is the source of problems in many circumstances. It seems oddly inconsistent that on the one hand, the overall thrust of the ''incremental abatement'' and job re-design obligation of OSHA's full ergonomics program will focus on avoiding or reducing exposures, while on the other, an employer's judgement to limit additional exposure is retaliatory or aimed at discouraging reporting (Ex. 500–1–140).

As with incentive programs and drug and alcohol testing policies, OSHA's concern about withholding overtime is based on the discriminatory application of this practice to discourage reporting or participation in the ergonomics program. The Agency realizes that work restrictions, including limitations on the number of hours worked, are often necessary to prevent an injured employee's condition from worsening and to allow damaged tissues to recover. The provision of work restrictions, however, must be viewed separately from the reporting of MSDs and MSD signs and symptoms.

If overtime is withheld as a matter of policy simply because a report of an MSD has been made, this could have the effect of discouraging reporting. An example of such a situation would be an employee who uses a keyboard in a steady manner for eight hours per day, then works an additional two hours as a receptionist and does not perform any work involving typing or hand activity during that two hours. If this employee were to report the signs and symptoms of an MSD of the wrist, and as a matter of policy was denied the opportunity to work overtime as a receptionist but continued working eight hours at a keyboard, the effect would be to discourage reporting and would be evaluated by OSHA as described above.

OSHA does not include production incentives in the category of policies and practices that may discourage reporting or participation in the program. Mosely and Associates registered concern as to how such systems would be viewed, and expressed concern that plants may lose their competitiveness if piece rate compensation systems or production incentives are abandoned (Ex. 30–4362).

OSHA recognizes that these systems sometimes cause employees to expose themselves to MSD hazards in order to achieve higher rates of compensation. Because piece rate incentives are not directly tied to reporting or participation in the ergonomics program, however, the Agency does not view them as potential sources of discouragement to reporting and participation. With full participation in the ergonomics program, employees compensated under these systems will be provided with the protections of the ergonomics standard, including the information and training that will confer with it the ability to recognize the potential causes of MSDs and knowledge of the importance of early intervention.

Several commenters (see, *e.g.,* Exs. 30–3853, 30–4247) argued that subjecting an employer to citation for maintaining policies or practices that discourage worker participation would be contrary to the intent of Congress. These commenters argued that, by placing a discrimination provision in Section 11(c) of the OSH Act, Congress had made clear that anti-discrimination provisions should not be included in standards. These commenters therefore believe it inappropriate for OSHA to include a discrimination provision in an ergonomics standard.

Paragraph (h)(3) of the final rule is intended to prevent employers not only from discriminating against employees for reporting and participating in the ergonomics program, but also to prevent employers from having policies that discourage employees from reporting and participating, even where no discrimination has taken place. Paragraph (h)(3) thus has a different scope than section 11(c). In addition, insofar as paragraph (h)(3) addresses discrimination, it does so as part of a broader standard that is reasonably necessary and appropriate to address a serious hazard . Nothing in Section 11(c) indicates that a standard issued in accordance with Section 6(b) may not include such a provision. Provides a different enforcement mechanism than section 11(c), and nothing in section 11(c) indicates that it is the exclusive means of addressing discriminatory policies.

Paragraph (i)—Employee Participation

Paragraph (i) sets forth the final rule's provisions regarding employee participation. It requires that employers ensure that employees and their representatives, if the employees are represented by a recognized or certified collective bargaining agent, have ways to report MSDs, MSD signs and symptoms, and MSD hazards; that employees receive prompt responses to those reports when they are made; that access to the standard and to information about MSDs and the ergonomics program be provided to employees; and that employees have ways to be involved in the development, implementation, and evaluation of the ergonomics program.

The requirements of paragraph (i) closely correspond with the requirements of the proposed employee participation section. This reflects OSHA's determination, based on evidence in the record, that the involvement of employees and their representatives in an ergonomics program is critical to the effectiveness of the program. It also reflects the support for the proposed employee participation provisions expressed by commenters.

The proposed employee participation requirements were designed to cover those circumstances where the involvement of workers was essential to the success of an ergonomics program. The duty to establish a means of reporting and to provide prompt responses to reports was included because of the vital importance of an effective reporting system to the proper function of the injury-based trigger of the standard. Access to the standard and information about the ergonomics program was considered by the Agency to be necessary for employees to participate effectively in the ergonomics program. Employee input into the development, implementation, and evaluation of ergonomic programs was considered critical to program success because of the first-hand knowledge that employees could offer regarding potential solutions to MSD hazards, the appropriate content and level of training, and the effectiveness of control measures.

The proposed provisions for employee participation generated a considerable volume of comment. Support for the concept of involving employees in the ergonomics program was widespread among commenters, and few disagreed with the proposed requirements pertaining to reporting, providing responses, and furnishing access to the standard and to information. Comment on these provisions in the context of employee participation was primarily limited to requests for clarification about how the provisions would apply in practice. Substantial differences were expressed, however, concerning the level of employee involvement appropriately included in a final standard.

The importance of employee participation in the successful implementation of an ergonomics program was stressed in a number of comments (see, *e.g.,* Exs. 30–276, 30–428, 30–651, 30–3860, 30–4333, 30–4468, 32–21–1–2, 32–82–1,Tr. 3479, Tr. 6930, Tr. 3565, Tr. 5596–5597, Tr. 10202, 32–450–1–18–1, Tr. 11182, Tr. 11380, Tr. 12947, Tr. 14479, Tr. 14902, Tr. 16526, Tr. 12366, 500–29, 500–117–2, 500–177–2, 500–220, 500–215, 601-x-1587, 20–605). Mark Catlin of the Alice Hamilton Occupational Health Center, for example, stated:

> Our experience has been * * * that when there is true employee involvement from beginning to end, especially in the development of solutions, that can be a great benefit in coming up with a program that works for that specific site that is cost effective and will be maintained after it is initially set up (Tr. 5597).

The advantages that the knowledge and skills of employees have lent to successful ergonomics programs were remarked upon by a number of commentors (see, *e.g.*, Tr. 4084, Tr. 4697, Tr. 6188, Tr. 7011, Tr. 7111, Tr. 7135, Tr. 7142, Tr. 9489, Tr. 10224, Tr. 10547, Tr. 11076, Tr. 12366, Tr. 12297, Tr. 13004, Tr. 14248, Tr. 14320, 20–406, Tr. 17623). For instance, Dr. Robert McCunney of the American College of Occupational and Environmental Medicine stated:

> In my experience as a physician, I have been impressed with the knowledge that a lot of workers have about their jobs and the recommendations that can be made to improve it and reduce factors associated with illness * * * [Tr. 17633].

One aspect of employee participation included in the proposal was a means for the employee to inform the employer when MSDs or MSD signs and symptoms occur. Reporting is essential to allow the employer to become aware of those job situations where further action is necessary. For example, if an employee experiences pain and stiffness in the shoulders and believes this to be the result of workplace factors, the employer cannot be expected to make changes to the workplace to mitigate the risk factors unless the employer is aware of the existence of a problem.

Belief in the importance of employee reporting of MSDs and their signs and symptoms was expressed in a number of comments on the proposed rule (see, *e.g.*, Exs. 30–240, 30–1104, 30–2116, 30–2215, 30–2387, 30–2809, 30–3686, 30–3765, 32–77–2, 30–3813, 30–3826, 30–3849, 30–3859, 30–4185, 30–4468, 30–4538, 30–4548, 30–4562, 30–4564, 30–4837, 31–78, 31–174, 31–192, 31–227, 31–303, 31–353, 32–82–1, 32–85–3, 32–461–1, 32–111–4, 32–210–2, 32–339–1, 500–33). For example, Shipman and Goodwin LLP, on behalf of an unnamed client, stated:

> Requesting that employees report signs and symptoms encourages the success of any early intervention program (Ex. 30–2215).

Comments received on this issue are presented in greater detail in the discussion of paragraph (d), which includes a requirement that employers provide information to their employees on how to report MSDs and their signs and symptoms. The ability of employees to report MSDs and MSD signs and symptoms depends upon their understanding of the reporting mechanism, and knowledge of what constitutes a possible MSD or MSD sign or symptom.

The final rule, at paragraph (h), adds ‘‘MSD hazards’’ to the list of things employers must ensure that employees report. OSHA believes that trained employees will be able to identify MSD hazards in their workplace *before* they cause MSDs, and this will result, in turn, in steps by proactive employers to protect workers at risk even before they suffer an MSD incident. The reporting of MSD hazards has therefore been added to paragraph (i)(2) of the final rule.

The specific process employers must establish for reporting MSDs, their signs and symptoms, and MSD hazards is not prescribed in this final rule. OSHA anticipates that the process will vary from workplace to workplace, based on the size and nature of the workplace. A large facility with an on-site health care professional (HCP), for example, may choose to handle reports through the HCP. Smaller facilities may elect to have reports made directly to supervisors. The method of submitting a report is likewise not specified. Employers may chose to adopt written, electronic, or other systems for receiving reports. (Note, however, that employers are required by paragraph (v) to keep records of employee reports, primarily for evaluation purposes.)

The final rule requires the employer to ensure that employees have ways ‘‘to promptly report’’ their MSDs, signs and symptoms, and hazards. OSHA received many comments on its use of the word ‘‘prompt’’ in the proposed rule (see, *e.g.*, Exs. 30–3826, 30–3853, 30–4467, 30–3284, 30–3367, 30–4674). These commenters asked OSHA to clarify what was meant by ‘‘prompt.’’ OSHA is using the word to indicate that timely reporting is required; the effectiveness of the standard and the employer's program would clearly be compromised if employees did not report their problems quickly, at a time when preventive action can still be taken. A rigid time frame, however, is not specified in the rule, because the Agency recognizes that some flexibility is needed to account for the circumstances found in different workplaces. In general, OSHA believes that reports should be received within a few days in almost all cases, and the Agency expects employers to inform their employees about the importance of early reporting, as required by paragraph (d).

OSHA proposed that employers provide prompt responses to employee reports of MSD signs and symptoms to encourage reporting and provide feedback. OSHA's reasons for proposing that employer responses to reports be made promptly was that timely and good faith responses are essential to reinforcing the information exchange process. Several commenters asked for clarification of this proposed provision (see, *e.g.*, Exs. 30–3344, 30–3367, 30–249, 30–3749). The Society for Human Resources Management, for example, asked OSHA to specify what it would consider an adequate response. The Society questioned whether OSHA would consider acknowledgment of receipt of the report, evaluation of the report, or action to prevent the condition from worsening as responses to the report. Others asked whether the response must be in writing or whether alternative methods of communication (*e.g.*, oral) would be acceptable (see, *e.g.*, Exs. 30–3344, 30–3367, 30–3826).

If an employee experiences persistent MSD symptoms and reports that condition to the employer but receives no response, that employee is likely to consider the ergonomics program ineffective. Such a loss of confidence in the program would clearly discourage future reporting and participation. If the employer communicates the results of evaluations made based on the report, or informs the employee of any actions that are being taken as a result, the reporting employee will better understand the process and will be more likely to participate in the future. OSHA also recognizes that employers will sometimes inform the employee that a given report requires no action, *e.g.*, when an MSD hazard turns out, on closer examination, not to warrant further action. OSHA continues to believe that prompt responses to reports are an essential part of the communication that must occur between employers and employees in a functioning ergonomics program, and final paragraph (i)(2) reflects this conviction.

In order to provide flexibility to employers to tailor communication methods to the needs of a particular workplace, the method of providing a response to employees who report is not specified. Employers may chose to adopt written, electronic, or other systems for providing responses, although a record of the response must be maintained, as required by paragraph (v).

OSHA proposed to require the employer to grant employees access to the standard and to include information about the ergonomics program. OSHA proposed this requirement to ensure that employees understood what the OSHA standard required and how the employer's program worked. The program was to include assignment of responsibilities in the ergonomics program; job hazard analysis results; hazard control plans; records of the occurrence of MSDs and reports of MSD hazards; ergonomic program evaluation results; and lists of alternative duty jobs, according to the preamble to the proposed rule [64 FR65799]. This provision recognized that information is important to full employee understanding of and participation in the ergonomics program.

OSHA was requested by commenters to define more clearly what was meant by ''access'' to the standard (Ex. 32–337–1). The Dow Chemical Company, for example (Ex. 30–3765) felt that employers should not be required to provide employees access to the standard. Dow argued that employers were required to comply with the provisions of the rule but should not be additionally burdened by providing access to the standard. In Dow's view, employees could be confused by receiving information both on the employer's ergonomics program and the standard.

The National Coalition on Ergonomics (Ex. 32–368–1) expressed concern that the employee participation provisions of the proposed standard would require employers to provide employees with access to the employer's confidential documents, which might address personnel issues, financial issues, or safety audits. If this were the case, the Coalition argued, employees with grudges or those involved in labor disputes would be able to harass their employer by disclosing or threatening to disclose proprietary information out of context or in a fashion that might have an adverse impact on the employer. The Coalition argued that this would discourage employers from performing audits with appropriate depth and thoroughness. Concern was also expressed that employee access might jeopardize medical confidentiality. (Ex. 500–1–116).

OSHA does not believe that providing employee access to the ergonomics standard is an unreasonable burden on employers, nor that providing the standard will confuse employees. Employee access to OSHA standards that affect them is a longstanding OSHA practice (see, for example, OSHA's rule's governing lead exposure, noise exposure, and so on). Access to the standard can be provided in several forms. A printed copy of the standard may be made available, or an electronic version may be provided on CD or via internet access to OSHA's web site if employees have access to a computer. OSHA believes that the standard will not be confusing to employees because they will be trained to understand the ergonomics program in their workplace and their role in it, in accordance with paragraph (t) of the final rule. OSHA does not believe that employees will flood their employees with requests to obtain and review the final standard; instead, the Agency believes that the standard is likely to be used primarily as a reference to compare the functioning of their workplace ergonomics program with the provisions of the standard to assure that the program is functioning properly and is in compliance.

Because of the importance OSHA attaches to employee access to the standard, and the relative ease of providing it, the final rule adds the term ''ready'' to the original access provision. This means that whenever an employee requests access to the standard, the employer must assure that ready access is provided, *i.e.,* that access is provided within a reasonable time and place.

Because of the importance OSHA places on employees being able to easily understand the requirements of the standard, the final rule requires employers to provide employees with a copy of the summary of the standard that is required to be made accessible in paragraph (d). Although the employer is required in paragraph (d) to make this information available to employees when they start a job, the employee should receive the summary at the time the program is implemented due to the fact that the exposures in the employees job have now been shown to exceed the levels in the Basic Screening Tool and considerable time may have passed since the employee was informed that he or she had access to this information. The summary sheet provided in Appendix B may be used for this purpose.

The Agency is also not persuaded by arguments that confidential company information or medical records would be distributed if employers provide employee access to information about the ergonomics program. The proposal specifically stated [64 FR 65799], and OSHA reiterates here, that information of a personal nature such as the medical records of other employees, is *not* included in the information to which employees are required to have access. Records of the occurrence of MSDs, for example, can be presented in a general form and do not need to include personal details. General injury and illness information is already available to employees under the provisions of 29 CFR 1904.7 with regard to the Log and Summary of recordable occupational injuries and illnesses.

OSHA also is not convinced by comments suggesting that proprietary information would be revealed if employees have access to program information. The information required to be made available, on request, is general information. For example, although an employee's detailed process and production plans might be trade secrets, the information required by this provision relates only to the control of ergonomic hazards. Technical information regarding machinery or production methods is clearly not required to be provided. Reports of MSD hazards and job hazard analysis results are not confidential and are critical information for employees if they are to participate meaningfully in the ergonomics program.

Providing employees with basic information about the common kinds of MSDs and their signs and symptoms is required by paragraph (d) of the final rule. The comments pertaining to this paragraph can be found in the summary and explanation for paragraph (d). OSHA has decided that information on MSDs and their signs and symptoms is so basic, and so important to employees, that it must be provided as part of employee participation as well. The final rule's employee participation provisions are only triggered when MSD incidents have been reported in a job that meets the action trigger. This means that the employees covered by final paragraph (i) are those who work in higher-risk jobs; these employees clearly need to be informed about MSDs and their signs and symptoms. Thus paragraph (i)(3) requires employers to inform their employees with, at a minimum, the information sheet in non-mandatory Appendix A. OSHA believes that most employers will choose to provide more detailed and specific information, such as information about the MSDs and signs and symptoms occurring among employees in jobs in their establishment.

The fourth component of the proposed employee participation section was a broad requirement that ''ways to be involved in developing, implementing and evaluating each element of the ergonomics program'' be provided to employees. This component, as explained in the preamble to the proposal, was designed to allow employers to take advantage of the knowledge, skills, and abilities that workers could contribute to the ergonomics program.

The United Steelworkers concurred with OSHA's initial assessment that employee involvement in each element of the ergonomics program was appropriate. The union stated:

Workers and their representatives have to be involved in all aspects of the introduction and implementation of an ergonomics program in [the] workplace. After all, it is their bodies and lives that are on the line (Ex. Tr. 11047).

Vagueness was a concern of some commenters. A number of interested parties indicated that they did not understand what level of employee involvement would be required under the proposed standard (see, *e.g.,* Exs. 30–3344, 30–3848, 30–4607, 30–4674, 30–4713, Tr. 4372). These commenters stated that the proposal did not make it clear whether an employer would have unlawfully limited employee participation if, for example, employee suggestions for ergonomics improvements were rejected (see, *e.g.,* Exs. 32–78–1, 30–4467, 30–541, 30–627, 30–652, 30–1355, 30–1697, 30–1717, 30–4843, 601–x–1710). These participants argued that employers should not be required to follow the recommendations of employees or obtain their concurrence on a course of action, and should retain the authority to make all final decisions about compliance with the requirements of the standard (see, *e.g.,* Exs. 30–3934, 30–2208).

Some industry representatives stated that the level of employee involvement proposed by the requirement that employers involve employees in developing, implementing and evaluating each element of the program was excessive (see, *e.g.,* Exs. 32–368–1, 32–78–1, 30–4467, 30–240, 30–276, 30–368, 30–429, 30–434, 30–541, 30–562, 30–652, 30–1070, 30–1294, 30–1671, 30–2830, 30–2846, 30–2991, 30–3344, 30–3348, 30–3784, 30–3951, 30–4185, 30–4713, 32–21–1, 32–120–1, Tr. 11679, 500–33, 30–3744). In the view of these commenters, OSHA did not demonstrate that this level of employee involvement was necessary for an effective ergonomics program (see, *e.g.,* Exs. 32–78–1, 30–4467, 30–541, 30–627, 30–1355, 30–1545, 30–1697, 30–1717, 30–2830). Employee involvement, although commonly acknowledged as often beneficial, was not needed in every situation, and should therefore not be mandated, according to these commenters. For example, Dr. Kurt Hegmann stated:

Hazard remediation efforts are frequently enhanced and accelerated with employee participation since the ones doing the work 40 hours a week have often thought of the most effective solution. Yet, requiring employee participation in this and other aspects of the rule is inappropriate, as these assumptions are not always true [Ex. 30–4779].

Employee involvement in supervisory training or the evaluation of management leadership, for example, were cited as program elements where employee involvement was not considered necessary (Ex. 32–78–1). In its comments on employee participation, the American College of Occupational and Environmental Medicine stated:

* * * employee participation in the design, modification, and evaluation of all aspects of an employer's operation is unnecessary. In most facilities, manufacturing or industrial engineers effectively perform many aspects of their jobs without employee participation. OSHA's requirement for employee participation should be limited to participation on ergonomics teams and participation in the job-specific problem solving process [Ex. 30–4468].

Another commenter with a similar view argued that an employer who is able to eliminate MSD hazards without employee participation should not be required to consult employees (Ex. 30–4467).

Several practical problems about how the proposed requirements would actually work in different situations were also raised. Union Carbide Corporation indicated that such involvement would be difficult to implement when the ergonomics program is developed on a corporate level:

Large employers such as Union Carbide develop their ergonomic programs on a corporate basis using professional staff. Of necessity, they rely on employees to assist in implementing the program, and employee evaluation of the program is always welcome. But where programs are developed on a corporate basis, it is sometimes difficult to involve employees in that development [Ex. 30–3784].

The Whirlpool Corporation believes that adhering to the requirements of the standard would hinder the company's ability to respond to ergonomic hazards when they are first identified. Safety teams that are trained to quickly identify, assess, and fix a hazard would be supplanted by the more cumbersome process required by the standard. Whirlpool believes that the standard requires the employer to obtain input from people who may have nothing to add to the process, which would increase the time and expense involved without providing any assurance that a better solution would be found (Ex. 30–4779).

Some employers interpreted the proposed requirement that employees be involved in developing the program to mean that, where a current ergonomics program already exists, the employer would be required to develop a new program (Ex. 30–3765). The Edison Electric Institute stated that it is impossible to consistently include employee involvement in all elements of the ergonomics program, and therefore recommended that the final rule allow greater flexibility to employers and only require that employees ''be provided adequate, regular opportunities to be involved in developing, implementing and evaluating appropriate elements of the program'' (Ex. 500–33).

The Northwest Food Processors Association expressed concern that engaging employees and their designated representatives in the ergonomics program could be inappropriate in some cases because the ergonomic interventions they suggested might result in the elimination of jobs or otherwise negatively impact employment opportunities. The association stated that employers should be given flexibility in the final rule to determine the appropriate approach to such situations (see, *e.g.,* Tr. 12198).

Some employers were concerned that employees could disrupt the program or decline to participate in it. These commenters believe that employee representatives may attempt to use the standard as a way to force unnecessary or costly changes for reasons unrelated to safety (see, *e.g.,* Exs. 30–2208, 30–1294, 30–3348). The Nabisco Company was concerned that requirements for employee participation could not be met if employees were unwilling to participate in the program. The company stated:

Nabisco strongly supports the concept of employee involvement and encourages participation of employees at all levels of our organization. However, this requirement assumes that employees and their representatives will readily volunteer to participate in a management program. It has been the experience within some of our locations that union representatives do not always encourage employee participation in management programs [Ex. 30–4201].

A common concern expressed by employers with unionized employees was that the requirements of the proposed standard for employee involvement could serve to disrupt established collective bargaining relationships (see, *e.g.,* Exs. 30–3853, 30–3765, 32–337–1, 30–323, 30–345, 30–538, 30–574, 30–1022, 30–1113, 30–1349, 30–1567, 30–1616, 30–1652, 30–2426, 30–2725, 30–2773, 30–3086, 30–3184, 30–3284, 30–3344, 30–3951, 31–332, 500–1–128, 32–266–1, 30–3841). Many companies and their unions, according to these commenters, have well-established contractual mechanisms for addressing employee safety and health issues. A typical example is a contract provision establishing a joint labor-management safety committee. According to the views of these commenters, requiring the employer to engage individual employees in the ergonomics program would stimulate resentment and conflict by forcing the employer to circumvent the union. PEPCO, for example, expressed this view:

PEPCO, like most utility companies, has a long-established relationship with a collective-bargaining agent that represents most of our employees (International Brotherhood of Electrical Workers, AFL–CIO). PEPCO has well-established contractual mechanisms for addressing employee safety and health issues. We have joint labor-management safety committees and include our union in accident investigations. The proposal would interfere in established relationships such as these, for in several instances, it would require the employer to deal with or involve not just the employee designated representative, but also the individual unionized employee. This places the employer in the position of having to deal apart from, or even circumventing, the union in order to avoid the risk of citation [Ex. 31–332].

Consolidated Edison Company of New York urged OSHA to address this issue by indicating that the obligations for employee involvement in the final rule could be met by affording those rights to the union (Ex. 30–2816). Alan Ferranto of the National Association of Letter Carriers, however, did not believe that collective bargaining relationships would be affected by the proposed rule:

Inevitably, when a proposal of this nature is put forth, there are those who will argue that collective bargaining will be affected. As the safety and health officer for a union which represents almost a quarter million postal employees, I'm here to say that this proposal will not affect our collective bargaining agreement with the postal service. In fact, we are satisfied that the employee involvement envisioned under OSHA's proposed ergonomic standard will complement the already agreed-upon procedures in place to address safety and health issues [Tr. 3570].

A number of labor representatives felt that the proposed requirement to involve employees and their designated representatives in developing, evaluating and implementing each element of the ergonomics program should be modified. Some parties expressed the opinion that the standard should be revised to add employee representatives to each provision where rights are granted to employees. For example, the proposed job hazard analysis provision would require the employer to ask employees whether performing the job poses physical difficulties; in the view of these commenters, this should be changed so that employees *and* their designated representatives should be consulted. The unions also suggested that the proposed control obligation section be revised to add designated representatives to the requirement to ask employees for control recommendations (see, *e.g.*, Exs. 32–339–1, 32–182–1, 32–198–4, 32–210–2, Tr. 3566).

Another commonly expressed concern of the employer community was that the proposed provision that employers provide employees ways to be involved in developing, implementing and evaluating each element of the ergonomics program would conflict with provisions of the National Labor Relations Act (NLRA) or with state laws addressing labor relations (see, *e.g.*, Exs. 30–296, 30–323, 30–328, 30–345, 30–368, 30–377, 30–397, 30–523, 30–532, 30–536, 30–380, 30–538, 30–540, 30–541, 30–562, 30–574, 30–589, 30–594, 30–598, 30–627, 30–630, 30–632, 30–648, 30–688, 30–1022, 30–1113, 30–1131, 30–1216, 30–1294, 30–1296, 30–1332, 30–1349, 30–1355, 30–1356, 30–1357, 30–1358, 30–1367, 30–1370, 30–1413, 30–1545, 30–1551, 30–1552, 30–1567, 30–1584, 30–1616, 30–1652, 30–1683, 30–1697, 30–1717, 30–1727, 30–1898, 30–1901, 30–2049, 30–2050, 30–2054, 30–2061, 30–2062, 30–2133, 30–2134, 30–2427, 30–2499, 30–2506, 30–2645, 30–2773, 30–2799, 30–2811, 30–2812, 30–2813, 30–2814, 30–2824, 30–2830, 30–2896, 30–2990, 30–3061, 30–3062, 30–3086, 30–3095, 30–3131, 30–3174, 30–3177, 30–3210, 30–3231, 30–3233, 30–3284, 30–3336, 30–3344, 30–3716, 30–3745, 30–3765, 30–3845, 30–3853, 32–337–1, 32–368–1, 30–3349, 30–3353, 30–3356, 30–3364, 30–3367, 30–3473, 30–3513, 30–3622, 30–3723, 30–3728, 30–3819, 30–3849, 30–4122, 30–4143, 30–4153, 30–4158, 30–4167, 30–4187, 30–4355, 30–4499, 30–4607, 30–4628, 30–4674, 30–4702, 30–4818, 30–4843, 31–266, 31–310, 31–332, 32–211–1, 32–234–2, Tr. 4320, Tr. 4908, Tr. 15537, Tr. 8896–8897, 30–3345, 500–1–27, 500–1–28, 500–1–29, 500–1–42, 500–1–79, 500–1–86, 500–1–106, 500–1–112, 500–1–113, 500–1–114, 500–1–116, 500–1–181, 500–1–117, 500–1–124, 500–1–125, 500–1–193, 500–1–248, 500–1–249, 500–1–307, 500–1–329, 500–1–331, 500–1–411, 500–1–423, 500–1–442, 500–177–2, 30–1942, 30–3236, 30–3339, 30–4535, 30–2600, 30–2592, 30–2577, 30–2583, 30–2256, 30–2259, 30–2201, 30–2243, 30–2260, 30–2272, 30–3428, 30–3157, 30–3158, 30–3196, 30–3623, 30–2550, 30–2543, 30–2529, 30–2535, 30–4583, 30–2896, 30–2894, 30–2886, 30–2868, 30–2863, 30–2862, 30–2854, 30–4668, 30–4302, 30–2106, 30–2404, 30–2405, 30–2407, 30–2406, 30–2412, 30–2292, 30–2293, 30–2300, 30–2287, 30–2447, 30–2370, 30–2605, 30–2614, 30–2772, 30–2791, 30–2793, 30–2828, 30–2831, 30–4058, 30–2474, 30–2487, 600–x–34, 600–x–36, 30–4762, 30–2901, 30–5036, 30–4566, 30–1971, 30–1972, 30–1973, 30–2571, 30–4541, 30–4786, 30–5027, 601–x–1370, 601–x–1698, 601–x–1712, 601–x–1439, 601–x–1440, 601–x–1441, 601–x–1442, 601–x–1444, 601–x–212, 601–x–213, 601–x–1368, 500–1–397, 30–3839, 30–4247, 30–4486, 601–x–1711, 601–x–1360, 30–3858, 30–3923, 30–4778, 30–2432, 30–3850, 30–2593, 30–3728, 30–2270, 30–1995, 30–2209, 30–3036, 30–2832, 30–2472, 30–2439, 30–2438, 30–2397, 30–2389, 30–4300, 30–4326, 30–1076, 30–4712, 30–2103, 30–3806, 30–1730, 30–1446, 30–3220, 30–3235, 30–4335, 30–4337, 30–4362, 30–4394, 30–4443, 30–4528, 30–4709, 30–1651, 30–2410, 30–2289, 30–3877, 30–2601, 30–3160, 30–3598, 30–2912, 30–1332, L30–5025, 30–4280, 30–1416, 30–1453, 30–1457, 30–1616, 30–1998, 30–1999, 30–2131, 30–2142, 30–2184, 30–2233, 30–2250, 30–2304, 30–2395, 30–2396, 30–2423, 30–2431, 30–2736, 30–2829, 30–2889, 30–2891, 30–2992, 30–3003, 30–3254, 30–3334, 30–3393, 30–3551, 30–3597, 30–3791, 30–3882, 30–3936, 30–3944, 30–3974, 30–3977, 30–3999, 30–4464, 30–4532, 30–4539, 30–4544, 30–4629, 30–4657, 30–4667, 30–4669, 30–4980, 30–5034, 30–5076, 30–5095, 30–5101, L30–4952, L30–4953, L30–5096, 30–3497, 30–1938, 30–1989, 30–2217, 30–2384, 30–2403, 30–2403, 30–2416, 30–2480, 30–2486, 30–2555, 30–2556, 30–2607, 30–2639, 30–2734, 30–2735, 30–2873, 30–2878, 30–3578, 30–3742, 30–3776, 30–4325, 30–4452, 30–4790, L30–4998). A discussion of the relationship between the requirements of this final rule and the NLRA can be found in the Legal Issues section of this preamble.

As has already been discussed, the potential value of employee contributions to the development, implementation, and evaluation of an ergonomics program is well-established. The intent of the proposed requirement that employees have ways to be involved in developing, implementing, and evaluating each program element was to allow employers to take advantage of this potential value to construct and administer the most effective program possible.

A requirement that employees be involved in the program in no way abrogates the authority of the employer to manage the workplace or administer the ergonomics program. Regarding employee suggestions, this general requirement of the final rule for employee involvement requires only that employers provide a reasonable opportunity for employees to be heard, for them to be involved, and for their suggestions to be fairly considered. An employee recommendation made as part of this process, in and of itself, does not oblige the employer to take action. For example, if an employer asks employees in a problem job for recommendations about eliminating or controlling MSD hazards, the employer is not compelled to adopt any of the suggestions that the employees may make. Rather, this is an opportunity for the employer to draw on the knowledge of these workers in identifying and examining alternative approaches to addressing hazards. The suggestions of employees may be used to supplement those of professional staff or consultants.

Along with the authority for making decisions, the employer retains the responsibility for ensuring the effectiveness of the program. If consultation with employees about the effectiveness of the program reveals, for example, that training has not been understood, then this deficiency must be promptly corrected (see paragraph (u) of the final rule).

OSHA realizes that the input of employees will not in every instance prove to be beneficial to the ergonomics program. Nevertheless, the evidence in the record shows that contributions to the success of ergonomics programs have consistently been made by participating employees. The involvement of employees need not be cumbersome or time-consuming. Brief discussions are often sufficient to elicit employee input.

The proposal would have required that employees have ways to be involved in developing, implementing, and evaluating each element of the ergonomics program. The final rule requires that employees be involved in developing, implementing, and evaluating the program; however, reference to ''each element'' of the program has been deleted. This change has been made to grant the employer flexibility to adapt employee involvement to the circumstances in a given workplace. OSHA is convinced that the proposed level of employee involvement is not practical or justified in every instance. The Agency never intended for employee involvement to pervade every aspect of the program. As explained in the preamble to the proposal, the ''elements'' referred to were the broad ergonomics program elements (*e.g.* training, program evaluation). A requirement for employee participation in each component of these elements, such as supervisory training, was not envisioned. OSHA considers, however, that even greater latitude is appropriate in order to allow the employer to most effectively construct and administer the ergonomics program. For example, a small employer could adopt a training presentation developed by a trade association even if employees in that workplace did not participate in the development of the presentation. The Agency believes, however, that such circumstances are the exception rather than the rule, and has retained the requirement for employee participation in the development, implementation, and evaluation of the ergonomics program due to the evidence of the value of worker involvement in each of these stages in the administration of the program.

OSHA considers that the development of an ergonomics program is not an event, but a continuing process. The work environment is rarely static; work methods and equipment often change over time, and as a result the physical demands upon workers and associated MSD hazards can change as well. Likewise, hazard control methods and training procedures can evolve over time. Changes in the workforce can also impact the effectiveness of an ergonomics program. The program may require adjustments to account for these changes. For example, if ergonomics training is conducted in English in a workplace where the employees speak and understand English, it may be effective. If that employer subsequently hires employees who do not understand English, an adjustment would be necessary to provide the training in a language the employees understand. Similarly, if new equipment is brought into a workplace, modifications to the ergonomics program may be necessary to control MSD hazards related to use of the new equipment or to provide appropriate training. It is in these types of situations, as well as in the initial creation of the ergonomics program, where the record demonstrates that the involvement of employees can prove invaluable.

In response to those employers who were concerned that the proposed standard would necessitate discontinuation of successful programs that did not incorporate employee involvement in their development, OSHA does not intend for the requirement in the final rule for employee participation in the development of ergonomics programs to apply retroactively to programs that have already been established. The Agency believes that such a requirement would result in an unnecessary expenditure of resources to duplicate the existing program. Rather, OSHA believes that the evaluation of the effectiveness of the existing program will result in the identification and correction of any deficiencies which may currently exist, and that employee involvement in the ongoing development of the program will result in continuous improvement in the program over time. Moreover, OSHA anticipates that the grandfather clause in paragraph (c) of this final rule will apply to many existing programs.

A successful ergonomics program also requires employee involvement in its implementation. Clearly, hazard controls cannot be effective if workers do not use them, and MSD management cannot be effective if injured workers do not report their injuries. A program cannot fulfill its objectives if it exists only on paper, and is not applied in the workplace. Ample opportunity is provided to demonstrate employee involvement in the implementation of the program through compliance with the specific requirements of the standard. For example, if a job has been found to be an MSD hazard due to repetition, and the appropriate control method has been determined to be rotating jobs so that no single employee spends more than three hours per day in that job, the employer must ensure that employees carry out the job rotation in order for it to be effective as a control measure.

Employee involvement in the evaluation of the ergonomics program is also needed to assure program effectiveness. For instance, workers in problem jobs are in the best position to determine if control measures are successfully controlling MSD hazards, or if new hazards have been created. Employees are also best able to recognize when training is inadequate or when opportunities for reporting of MSD hazards or MSD signs and symptoms are unsatisfactory. As with employee involvement in the implementation of the program, opportunities to demonstrate employee involvement in the evaluation of the program can be found in the specific requirements for evaluation found in the standard, such as the requirement of paragraph (m)(4) for consultation with employees regarding the effectiveness of controls and the requirement of (u)(1)(i) for consultation with employees on effectiveness and problems with the program.

OSHA does not believe that employee participation in the ergonomics program under this final rule will result in adverse repercussions on collective bargaining relationships. The final rule also does not require employers in any way to circumvent any process that may currently exist for employer communication with the employee. The rule does not specify a precise mechanism that must be used for employee participation. Where a system is already in place, such as a union/management safety and health committee, nothing in this rule prohibits an employer from using that system to meet its employee participation obligations.

Paragraph (j)—What Must I Do To Determine Whether a Job That Meets That Action Trigger Poses an MSD Hazard to Employees in That Job?

This paragraph addresses the job hazard analyses employers must perform to identify those MSD hazards that must be controlled under this final standard. Paragraph (j)(1) of the final standard requires employers with jobs that meet the standard's two-part action trigger—*i.e.,* who have employees who have experienced an MSD incident and who work in jobs that have risk factors present at levels that meet the screen in Table W–1—to conduct a job hazard analysis of the job to determine whether it presents an MSD hazard to employees. (Employers who qualify for and choose to use the Quick Fix option contained in paragraph (o) of the standard must follow the procedures of that paragraph and are not required to conduct the job hazard analysis specified in this paragraph (j).)

Paragraph (j)(2) tells employers what steps they must include in a job hazard analysis, and paragraph (j)(3) lists the methods of job hazard analysis that are acceptable under the rule, including referring to a number of tools, included in Appendices D–1 and D–2 of the standard, that employers can use to conduct their analyses. Paragraph (j)(4) explains that if the job hazard analysis shows that hazards need to be reduced, the job is terms a ''problem job'' under this standard.

The proposal's job hazard analysis provisions listed the steps required to analyze a job, and contained a list of 20 physical work activities and conditions associated with particular risk factors. The proposal did not provide specific guidance on how to determine whether the risk factors presented an MSD hazard in any particular case. Several commenters argued that the proposal's approach was vague and asked for more specific measures for identifying MSD hazards (see, *e.g.*, Exs. 500–197, 30–2435, 30–973, 30–1274, 30–2426, 30–1350, 30–2428, 30–2986, 30–3000, 30–3086, 30–3853, 30–326, 30–546, 30–4189). Others (*e.g.,* Ex. 30–3593) thought that the requirements in the proposed job hazard analysis section were too specific, and still others stated that the table oversimplified the complex interactions between various risk factors in a job and urged OSHA to eliminate the table of physical work activities from the final rule (see, *e.g.,* Ex. 30–3436). The argument made by several commenters was that the work activities and risk factors included in the table in the proposal would be hard for employers to identify in the workplace (see, *e.g.,* Exs. 500–197, p. III–12, 30–3745, 30–2134, 30–2426, 30–2919).

Although some provisions in final paragraph (j) are essentially the same as the corresponding sections of the proposed rule, several have been revised in response to comments that the proposal did not provide enough information on how employers could determine whether MSD hazards were present. In particular, the inclusion of the tools in this rule provides employers with much more assistance in compliance than the job hazard analysis provisions in the proposal (proposed sections 1910.917 and 1910.918) would have, while preserving a high degree flexibility for employers who do not choose to use any of the listed tools. In addition, the final rule has been modified to allow employers additional flexibility in several aspects of the job hazard analysis process. The following discussion describes each provision of paragraph (j) of the final rule and OSHA's responses to the comments received on the proposed job hazard analysis provisions.

Paragraph (j)(1)

Paragraph (j)(1) of the final rule states that employers must conduct a job hazard analysis to determine whether a job that meets the action trigger presents an MSD hazard to employees in that job. This requirement is essentially identical to the job hazard analysis obligation in Section 1910.917 of the proposed rule. Like the proposal, the final rule does not require the employer to perform a job hazard analysis for every reported MSD, but only for those that meet screening criteria. Unlike proposed Section 1910.917, however, Paragraph (j)(1) also permits an employer to rely on a job hazard analysis that was conducted previously for the job, provided that the analysis was performed in accordance with the procedures of this paragraph (j) and is still relevant to the job (*i.e.*, the job has not been altered in the meantime in a way likely to change or increase exposure).

The purpose of job hazard analysis is threefold: (1) To identify all the ergonomic risk factors that are associated with the job being analyzed; (2) to measure the duration, frequency and magnitude of employee exposure to these risk factors; and (3) to evaluate the risk factors identified, individually and in combination. This analysis allows employers to determine if the job poses an MSD hazard to employees, *i.e.*, is a ''problem job,'' as that term is used in the standard. The results of the job analysis, which identify the extent of the risk factors present in the job, can later be used as the benchmark against which to measure the effectiveness of controls.

The NIOSH publication, Elements of Ergonomics Programs (Ex. 26–2), describes a job hazard analysis as an examination of the workplace conditions and individual elements or tasks of a job to identify and assess the risk factors that are reasonably likely to be causing or contributing to the reported MSDs. OSHA received many comments supporting its proposed approach to job hazard analysis (see, *e.g.*, Tr. 5342, Tr. 8978, Exs. 37–1, 37–25, 500–218, 500–137–1–1). OSHA thus believes that the requirements of paragraph (j) are consistent with the objectives and steps of job hazard analysis as the process is currently applied by employers with effective ergonomics programs.

The quality of the job hazard analysis performed is critical to the success of the entire ergonomics program, as the United Auto Workers noted:

> The heart of an ergonomics program is the measurement of risk factors on jobs. The presence of risk factors demonstrates that a reported MSD is related to a job or workstation, while their absence suggests the MSD arose from other causes. Risk factors predict MSDs will arise in the future, even if none are currently reported. And, reductions in risk factors indicate that a job has been improved (Ex. 500–220).

A job hazard analysis can also rule out jobs that do not need to be controlled, and can provide employers with the information they need to prioritize their efforts on the most hazardous jobs or tasks that pose the most severe problems. Similarly, a job hazard analysis is an efficient way to help employers focus their resources on the most likely causes of a problem. For example, after analyzing a job, the employer may find that the amount of repetition is acceptable if the force and awkward posture in the job can be controlled sufficiently.

Despite these benefits, several commenters (see, *e.g.*, Exs. 30–1393, 30–1275, 30–3061, 30–3062) were concerned that the standard's requirements for job hazard analysis would be too costly. Typical of these comments was one from the Navy Federal Credit Union:

> The requirement for employers to perform job hazard analyses is extremely onerous and costly. It requires every employer to perform hazard analyses on the same or similar jobs within their industry. OSHA has already amassed a substantial amount of data on the likely causes and remedies of MSDs that occur in the workplace. The ergonomics standard should permit employers to rely on OSHA's identification of hazards and possible remedies for problem occupations (Ex. 30–1273).

Other employers, such as August Mack Environmental, Inc., disagreed, however:

> I do agree that conducting a hazard analysis, if done properly and very objectively, requires significant resources. However, if the result were to find that MSD risk factors were not prevalent, and the need for full implementation of a comprehensive ergonomics program were eliminated, this [expense] could easily be justified. This is due to the estimated amount of resources required for the hazard analysis compared to the resources required to implement a formalized ergonomics program and maintain it over time (Ex. 30–240).

Other record evidence also makes clear that the cost of MSDs far exceeds the costs of controlling MSD hazards (Tr. 7122, Tr. 10225, Tr. 4811).

Similarly, some commenters also expressed concern that performing job hazard analysis could be too difficult for small companies (see, *e.g.*, Exs. 601–x–1, 30–3469, 30–2846). However, OSHA's experience is that small companies can and do conduct these analyses effectively. For example, Wood Pro Industries in Cabool, Missouri is a VPP employer with only 100 employees. Its safety director (David Carroll, who also wears a number of other hats) began a safety and health program that identified and controlled ergonomic risk factors several years ago. The program has resulted in a decrease of almost 40% in workers' compensation costs (mostly due to reductions in MSD hazards), with premium costs declining from $103,824 to $61,000, which Mr. Carroll described as ''not chicken feed for a small company'' (Ex. 502–17). Based on this record, OSHA agrees with those who commented that an appropriate job hazard analysis actually limits MSD hazard control costs, either by determining that no MSD hazard is present or by identifying risk factors that, in turn, allow the company to focus on the activities that are associated with the MSD incident.

The UAW also has experience with small companies that have implemented ergonomics programs:

> Employers in the many small facilities have voluntarily or through the collective bargaining process, adopted a common approach to preventing ergonomic injuries and abating ergonomic risk factors in the workplace. The program includes all components established in the proposed standard, except appropriate medical management and that can be established without hindering the established processes at the facilities (Ex. 500–220).

Other commenters argued that the proposed approach to job hazard analysis would require the employer to hire a consultant (see, *e.g.,* Exs. 30–3783, 30–2810, 30–3336, 30–715, 30–2834). For example, the Texas Association of Business and Chamber of Commerce stated:

> Because the proposed standard inadequately defines the alleged ''risk factors'' or ''conditions or activities'' or even to provide a complete list of the ''conditions or activities'' during which the ''MSD hazards'' allegedly occur, small employers will be forced to seek assistance—at substantial cost—from those with experience and knowledge in the ergonomics field. In addition, the proposed standard does not adequately explain which controls will abate particular hazards and they will again be forced, and as encouraged by OSHA, to seek expensive outside help (Ex. 30–2810).

But contrary evidence is also in the record:

> I am not an ergonomist and I do not believe you need an ergonomist to do a general check on the risk factors of most jobs, that most workers, especially if you give them a framework for thinking about and analyzing their own job, can tell you where those risk factors are present, where they're not present, where they're present in large quantities versus small quantities. You do not need to be an ergonomist to do that. Many workers are extremely capable, if you give them a framework for analyzing their own jobs * * * (Tr. 13764).

A recent study in the record (Ex. 500–71–64) reports that trained workers were able, in 65 to 85% of cases, to identify the same risk factors as hired ergonomists and to successfully identify solutions.

The job hazard analysis required by Paragraph (j) of the final rule serves a very different function from the Basic Screening Tool in Table W–1 of the standard. The Basic Screening Tool is a simple hazard identification tool that can be used to identify jobs with the *potential* to expose workers in them to ergonomic risk factors at levels that *may* pose an MSD hazard. It cannot take the place of a job hazard analysis. It can only point to possible problems with the job; it takes a job hazard analysis to determine whether controls are actually necessary. A job hazard analysis identifies specific risk factors, or combinations of risk factors, that need to be controlled.

Paragraph (j)(1) also allows employers to rely on a previously conducted analysis of a job if it was performed in accord with the requirements of this paragraph, and the analysis is still relevant. This provision responds to concerns expressed by some participants that employers that the standard would require significant action every time a new MSD occurred, even if a job hazard analysis that complied with the standard had already shown that no additional controls are necessary (*e.g.,* Ex. 30–3956). To take advantage of this provision, the employer must confirm that the job is still being performed in the same way, and that the same risk factors are still present. Any changes to the work methods or equipment may have introduced new MSD hazards, and a new job hazard analysis would then be required. Additionally, if new employees are present, the employer must make sure that no new employee is performing the job in a different way or has physical characteristics that expose that employee to risk factors not present for others. For example, a particularly tall or short employee might need to work in a more awkward position, or reach further than others in order to perform the same tasks. If that is true, the employer must analyze the job to identify the risk factors affecting that employee.

The ''new employee'' situation described above is one of the scenarios addressed by the Note to paragraph (j). That note allows the employer to limit the job hazard analysis (and response) to the employee who reported the MSD incident when the MSD hazard is limited only to that employee. Evidence in the record points to situations in which the physical work activities or conditions of a job pose a risk to only a single employee (see, *e.g.,* Exs. 30–

4709, p. 6, 500–145, 30–2208). For example, a five-foot tall employee in a commercial bakery may report a back or shoulder MSD related to extended reaches involved in sorting rolls. However, other, taller, employees who have performed the job for several years do not have (and never have had) difficulty performing the physical work activities of the job. In this case, the employer could conclude, based on the job hazard analysis, that the problem is limited to the injured employee. The employer then may limit the further action required by the standard (*e.g.,* analysis, control, training, recordkeeping, evaluation) to that employee's workstation.

A similar situation could occur where one employee is much taller than others in the same job. The tall employee reports persistent back pain that rises to the level of an MSD incident, and the employer observes that having to bend much further than the other employees to work at the work surface is likely to have caused the back problem. Allowing employers to limit the analysis and control to a single employee if the analysis reveals that the problem is unique to that employee is consistent with the approach taken by several commenters who have successful ergonomics programs (see, *e.g.,* Exs. 30–1071, 30–3755, 30–3745). As one of these commenters reported, ''we have often modified the job to fit that one individual—however, modification was not needed for co-workers at similar or identical duty stations'' (Ex. 30–1071).

Paragraph (j)(2)

Paragraph (j)(2) of the final rule describes the steps the employer must take in performing the job hazard analysis. Paragraph (j)(2)(i) states that the employer must talk to the employees who perform the job, and their representatives, about tasks that may relate to the MSD incident. Paragraph (j)(2)(ii) requires the employer to observe the employees performing the job to identify the risk factors and assess the extent of their exposure (its magnitude, frequency, and duration) to those risk factors. The employer must include all of the employees performing the job, or a sample of those with the greatest exposure to risk factors, in this analysis.

According to the record (see, *e.g.,* Exs. 26–2, 26–5, 26–1370, 37–1, 37–25) effective job hazard analyses have the following steps or activities in common:

- Obtaining information about the specific tasks or actions the job involves;
- Obtaining information about the job and problems in it from employees who perform the job;
- Observing employees performing the job;
- Identifying specific risk factors in the job; and
- Evaluating those factors (*i.e.,* their duration, frequency and magnitude) to determine whether they are causing or contributing to the problem.

The job hazard analysis requirements of the final rule reflect these steps. Unless the employer qualifies for and chooses the Quick Fix Option in paragraph (o), the employer must use the job hazard analysis process in this paragraph to determine whether the physical work activities and job conditions pose an MSD hazard to workers in that job. Jobs that pose an MSD hazard to employees are called ''problem jobs,'' and must be controlled in accordance with paragraphs (k) through (m) of this final rule.

When employers perform a comprehensive job hazard analysis, their goal is to identify those ergonomic risk factors that impose biomechanical stress on the worker and evaluate magnitude, frequency, and duration as required by paragraphs (j)(2)(ii) and (j)(3). Once the risk factors and their magnitude, frequency, and duration have been determined, the employer is required to assess whether the risk factors identified pose an MSD hazard to employees. The standard defines an MSD hazard as the ''presence of risk factors in a job at a level of magnitude, frequency, and/or duration that is reasonably likely to cause MSDs that result in work restrictions or medical treatment beyond first aid.'' Ergonomic risk factors are the elements of MSD hazards, and they often work synergistically. That is, jobs that have multiple risk factors pose a greater risk, all things equal, than a single risk factor.

Paragraph (j)(2)(i)

Paragraph (j)(2)(i) of the final rule requires employers to talk with employees and their representatives about the tasks the employees perform that may relate to MSDs. Much has been written about the value of employee participation in the identification of risk factors and controls at the hazard analysis stage (see, *e.g.,* Exs. 3–232, 26–4, 26–11, 26–15, 26–18, 26–19, 26–21, 26–1370, 26–1420, 32–339–1–42, 38–32). Studies have shown substantial improvements in health and safety after participatory ergonomics programs are implements (*e.g.* Ex. 32–38). A comment from Johnson & Johnson sums up the opinion of many participants:

> Hazards cannot be addressed efficiently without an accurate evaluation of the situation. The line employee is one of the best sources of this information * * * [those employees are] local process experts (Ex. 3–232).

The record contains considerable evidence that many employers talk to employees to get insight into the job requirements that only those who work at the job can provide (see, *e.g.,* Exs. 30–3755, 30–3748, 500–117, 500–137–1–1, 500–137–6–1, 500–218, 500–220, Tr. 3890, 13808). These commenters stated that talking with employees is often the best way to identify the causes of the problem and to identify the most cost-effective solutions to it (see, *e.g.,* Ex. 26–1370). One stated:

> Employee participation is vital to this element. Job Safety Analysis (JSA) [another name for job hazard analysis] has been part of the safety vocabulary for many years. Many employers are working with the workers to determine the safest way to do a job. Controlling a hazard can be a productive tool in many ways. Minimize lost time; reduce training and overtime; and a positive outlook from the workplace. A worker who is set up to succeed is a productive worker. A worker who has to jury rig or perform a task that leaves him or her in discomfort at the end of every shift can not be productive for a prolonged period of time. (Ex. 500–137)

Discussions with employers who have set up ergonomics programs in response to corporate settlement agreements with OSHA also confirm the need for employee input into the job hazard analysis process (Ex. 26–1420). A number of these employers said that employees need to be involved in the analysis and control process because ''no one knows the job better than the person who does it'' (Ex. 26–1420, See also Ex. 3–164). Other evidence echoed this concept, confirming that employees often have the best understanding of what it takes to perform each task in a job, and thus, what parts of the job are the hardest to perform or pose the greatest difficulties: ''The people that are closest to doing the work seem to come up with the best solutions.'' Tr. 4697.

In addition to helping to ensure that the job hazard analysis is accurate, involving employees can make the job hazard analysis and control process more efficient, because employees can help employers pinpoint the causes of problems more quickly. Employees often come up with some of the most practical, no-cost or cost-effective, solutions (see, *e.g.,* Ex. 26–Tr. 1370, 2136, 2582, 12297).

Some participants opposed this provision, however (see, *e.g.,* Exs. 30–3344, 30–74, 30–3557). Several expressed concern that asking employees about ergonomic problems would influence the employees' response, with the result that specious problems would be identified:

> This section is a regulatory ''Field of Dreams.'' Ask it and they will answer. Sooner or later, for reasons good, bad, or indifferent, somebody will answer ''yes'' [when asked if the job presents physical difficulties]. (Ex. 30–74)

Another participant was concerned that employee comments would vary from employee to employee and thus not be useful (Tr. 8861). Finally, several commenters argued that the employer and employee should not discuss the risk factors present in ''normal job activities'' because doing so might cause employees to feel that there should be no stress on the job (Exs. 30–3354, 30–3848).

OSHA continues to believe that employees' views add significant value to the job hazard analysis process and, in fact, that not asking employees about their perception of the tasks that may cause MSDs would be akin to performing a quality survey without involving the customer. Therefore, the final rule requires the employer to talk with the employees who perform the task when conducting this step of the job hazard analysis process.

OSHA is, moreover, providing enough flexibility in this provision to accommodate employers' concerns. OSHA is not requiring employers to use any particular method to talk with employees about the tasks they perform. Employers may do something as simple as talking with employees informally while observing the job being performed, or they may choose to talk with employees as part of a regular staff or production meeting. Alternatively, employers may have affected employees fill out a survey form or questionnaire. Many employers have developed effective tools for gathering important job information from employees who do the job. For example:

> AMP Inc., a manufacturer of electronic components, with 300 employees, uses a one-page ''Ergonomic Evaluation Form'' that asks employees to answer simple ''yes/no'' questions about the employee's ease and comfort when performing certain job tasks. After the company's ergonomic team (comprised of line employees) reviews the form, a member of the team interviews the employee. (Ex. 26–5).

In addition, there are ways to ask questions that respond to the concerns expressed above. The questions may be posed to minimize bias. For example, questions like ''Are parts of your job more difficult than others?'', ''Does your injury hurt more when performing certain tasks?'', or ''Could you recommend improvements to the job?'' tend to elicit useful information and do not prejudge the answer (Exs. 32–339–1–82, 500–121–61). In any event, the employee input is only one aspect of the job hazard analysis. The employer need not place great weight on the views of a single employee when those views are inconsistent with the rest of the information obtained during the analysis.

The final rule adds the language ''and employee representatives'' to this provision consistent with the practice in the rest of the rule to include the ''employee representative'' language included in each provision of the standard where OSHA is requiring such participation. The proposal took a more general approach to this issue, *i.e.*, it would have required employers to decide when including employee representatives was important in ''developing, implementing, and evaluating the employer's program'' (64 FR 66070).

A few commenters also stated that the appropriate focus for a job hazard analysis is the task rather than the job and objected to OSHA's use, in the proposal, of the word ''job'' in connection with the component to be analyzed in a job hazard analysis (see, *e.g.*, Exs. 32–300–1, 30–3755). OSHA agrees, and the language of the final rule uses ''tasks'' instead of ''jobs'' when referring to the units of analysis in this process.

Paragraph (j)(2)(ii) requires employers to observe the employees performing the job to identify the risk factors in the job, and to evaluate the magnitude, frequency, and duration of exposure to these risk factors. Job observation allows the employer to see how the employee does the job and provides information about the workstation layout, tools, methods, equipment and general environmental conditions in the workplace. A number of commenters recognized the value of this step (Ex. 30–3755). This paragraph of the final rule combines paragraphs (c) and (d) of proposed section 1910.918. Observing the employees at work is important because it allows employers to see precisely which tasks may be imposing biomechanical stress on the worker. Observation is a necessary addition to the discussion required by paragraph (j)(2)(i) because some things may be overlooked in the discussion, or employees may not remember to mention certain activities (particularly those that are short term).

There are several ways employers may comply with the observation requirement in paragraph (j)(2)(ii) of the standard, and participants described how they integrate job observations into their job hazard analysis (see, *e.g.*, Tr. 8171, Tr. 11133). First, employers may simply observe employees perform the job tasks; this is often all it takes to identify the problem. For example, watching a data processor reaching to use the mouse because the keyboard tray is not long enough to accommodate it may be all it takes to identify the likely cause of the employee's shoulder pain. Videotaping the job is another common practice for observing jobs (see, *e.g.*, Ex. 32–198–4). A number of employers, especially in situations where the work activities are complex or the causes of the problem not be easily identifiable, report that they videotape or photograph the job (see, *e.g.*, Ex. 26–1370; Tr. 3059, 4696, 6979, 7075, 5805, 5540, 10183).

The value of simply looking at people performing a job was demonstrated graphically at the hearing. A law firm representing a number of participants showed several ergonomist witnesses pictures of two workers seated at computer workstations (Ex. DC 42), and asked the witnesses to identify the risk factors observable in the photo. Virtually all of the witnesses (Tr. 1754, Tr. 1756, Tr. 2249, Tr. 2325–2327, Tr. 5397, Tr. 9045, Tr. 13228, Tr. 13235, Tr. 13307, Tr. 13762) explained that it would normally be necessary to ask the employees in the jobs reflected in the photos pertinent facts about the job before being able to determine with any certainty whether the exposure represented in the snapshot posed an MSD hazard to the worker:

> Well, again, it would go back to what they were doing. If they were doing this job for a long period of time (Tr. 928).

Nonetheless, when pressed to give the best answer possible based on the limited amount of available evidence, the witnesses reviewing the photos were surprisingly consistent in their identification of ergonomic risk factors across witnesses. The table below summarizes the witnesses' responses to the snapshot.

Risk factors—shorter worker	Identified by	Risk factors—taller worker	Identified by
Contact Stress	Armstrong (TR. 928), Alexander (TR. 2249), Fernandez (TR. 5384), LeGrande (TR. 9047), Brossard (TR. 13221), Robbins (TR. 1362).	Awkward neck posture	Armstrong (TR. 929), Alexander (TR. 2250), Fernandez (TR. 5380), Brossard (TR. 13228), Rich (TR. 9590).
Static Posture	Armstrong (TR. 928), Fernandez (TR. 5384), LeGrande (TR. 4096), Rich (TR. 9592).	Static posture	Fernandez (TR. 5380), Rich (TR. (9592).
Awkward neck posture	Alexander (TR. 2250), Fernandez (TR. 5385), Brossard (TR. 13224).	Awkward wrist posture	Rich (TR. 9598).
Awkward back posture	LeGrande (TR. 4096), Brossard (TR. 13225), Rich (TR. 9601).	Awkward back posture	Brossard (TR. 13227).
		Awkward knee posture	Fernandez (TR. 5381), Brossard (TR. 13226), Rich (TR. 9596).
		Contact Stress	Brossard (TR. 13230).

Although the participants who questioned these experts later claimed that the exchanges demonstrated ''erratic inconsistency'' in the identification of MSD hazards among OSHA's own experts (Ex. 500–197 at II–23), OSHA believes they show just the opposite: that it is often possible to identify risk factors easily even with only limited knowledge of the employee's activities. If the witnesses had had access to the extra information they all agreed was necessary, OSHA expects that there answers would have demonstrated much more uniformity.

''Same Jobs''

Paragraph (j)(2) of the final rule requires that employers include in the job hazard analysis (and control process) not only the injured employee's individual job but also all other jobs in the establishment that are the ''same'' as that job. ''Same jobs'' are jobs that involve the same physical work activities and tasks as the job that the injured employee performs, regardless of their job title or classification. (See the definition of ''job'' in paragraph (z)). All same jobs in the establishment must be included in the job hazard analysis and control process, even if they are performed at different locations or on different shifts. The standard, however, does not require employers to apply the job hazard analysis and control process to same jobs in other establishments.

The proposed rule contained an analogous provision, which a number of commenters supported (Exs. 30–4200, 500–215, Tr. 12894). For example, Suzanne Rodgers, a nationally recognized ergonomist who has been helping companies to develop effective ergonomics programs for more than 32 years, wrote in Occupational Medicine:

> The questions asked on site will give a good appreciation of the overall demands of the job * * * It is important, therefore, to look at more than one person doing the job, so individual methods can be assessed and the degree of individual control is known (Ex. 500–121–61).

Other commenters, however, objected to including all same jobs in the analysis (Exs. 30–2208, 30–3765, 500–145). For instance, Larry Feeler, a physical therapist and president of WorkSTEPS, Inc., said that including all same jobs would be too burdensome and costly for employers (Ex. 500–145). And P.J. Edington, of the Center for Office Technology, was concerned that it would be difficult for some employers to determine whether employees were performing the ''same job'' and that OSHA compliance officers might mistakenly classify all office work jobs as the ''same job'' (Ex. 30–2208; see also Ex. 500–197). Some commenters urged OSHA to limit the job hazard analysis requirement only to the injured employee's individual job (see, *e.g.*, Exs. 500–145, 30–2208), or only to other employees on the same shift (see, *e.g.*, 30–3765).

For several reasons, OSHA believes the requirement to analyze other jobs that are the same as that in which an MSD incident occurred is necessary to the final rule. At the same time, OSHA acknowledges the commenters' concerns and has included additional explanation and examples of ''same jobs'' in this preamble section, as well as providing flexibility for employers who have a large number of employees in the same job. The requirement is important because it helps to make the final rule more proactive and preventive. It ensures that employees performing the same physical work activities or tasks as someone who already has been injured are provided with protection before they too are hurt. As one commenter put it, the first injured employee may well be a ''harbinger'' of other MSDs among employees in the same job (Ex. 30–3755).

Second, it is likely that other employees performing the same job will need protection since the job has already been shown to involve exposure levels that are associated with increased risks of injury. As explained in the discussion of paragraph (f), jobs that meet the Basic Screening Tool generally pose a risk of MSDs that is three times higher than jobs that do not. Third, the requirement is necessary to ensure that employers have complete information about the hazards in the job. If the job hazard analysis is limited to the injured employee's job, employers may not get the information necessary to identify the causes of the problem accurately. Without this information, the control measures employers implement might not be successful in controlling or reducing the hazards to the required levels.

In any event, OSHA believes that the ''same job'' requirement will not impose undue burdens on employers. As the Note to this paragraph explains, like the proposal, the requirement does not apply where employers have reason to believe that an MSD hazard only poses a risk to the employee who experienced the MSD incident. Commenters generally supported this limitation (Exs. 30–4540, 30–1353, 500–145). Similarly, where employers have reason to believe that MSD hazards are present in only a subset of the same jobs, then employers would be permitted to limit their response to that group. For example, where it is clear that the size or width of the grip on a knife poses a hazard only for employees with small hands (*i.e.*, need for high hand force in order to hold knife), the employer would be free to limit the analysis to employees with small hands.

In addition, in most establishments, relatively few employees perform the same job. This is especially true for small employers. However, even where many employees at an establishment perform the same job (*e.g.*, telephone operators, letter sorters, package sorters, package delivery, beverage delivery, trash collectors, janitors, hotel maids), the final rule gives employers the option of including only a sample of those employees in the analysis.

Some commenters asked OSHA to clarify when jobs are the same (see, *e.g.*, Ex. 30–3784). Jobs are the same when workers perform the same physical work activities or same job tasks. Employees perform the same job when the discrete elements or physical actions they perform are the same, even if not every aspect of their jobs is identical. For example,

• Employees whose jobs involve picking up packages from one conveyor and putting them onto another are performing the same job, even if the packages contain different products, or are placed on different conveyors.

• Orderlies whose job tasks involve lifting and moving patients have the same job even though some characteristics of the patients, room layout and the purpose of the lift or move may vary each time.

• Garbage collectors who pick up trash cans and recycle bins, and dump their contents into the garbage truck, have the same job even though their routes are not identical (*e.g.*, variations in terrain, traffic, distance from residences).

On the other hand, just because the workstations, tools and equipment employees use is the same does not mean that these employees have the same job. For example:

• Employees who use VDTs do not have the same job where one employee's job involves steady typing for most of the workday while the other employee uses the VDT to read and send electronic messages for only a few hours a day.

• Employees in an automotive assembly plant who use glue guns or staple guns do not necessarily have the same job if they are assembling different aspects of the product (installing seats versus windshields), particularly if they use the tools in different ways, with different force, and in different positions.

For purposes of this standard, job titles or classifications do not determine whether employees are in the same job. Where employees are performing the same physical work activities or tasks, they are in the same job even if they have different job titles. Often jobs involving the same physical work activities may have different job titles if there are working supervisors, some kinds of seniority systems, or different work shifts. For example, a ''Fabricator II'' on the third shift may be performing the same physical work activities as a ''Junior Fabricator II'' or ''Apprentice Fabricator'' on the first shift.

At the same time, just because employees have the same job title does not mean that the employer must include them in the job hazard analysis if the job tasks are not the same. This is especially true when employers have general job classifications, such as office worker, assembly line workers, production staff. ''Office workers'' may be assigned to tasks as varied as answering phones, operating copy machines, filing, or typing. If the MSD incident affected an office worker typing documents, the employer would only need to include in the job hazard analysis other office workers whose work task is to type documents. Likewise, ''lineworkers'' or ''production workers'' in a poultry processing plant may perform very different tasks.

Sample of Employees

Paragraph (j)(2) also gives employers the option to include in the job hazard analysis only a sample of the employees in the same job. Where the employer elects to use a sample of employees, the sample must include those employees with the greatest exposure to the ''relevant risk factors'' (*i.e.,* those risk factors that exceed the levels on the Basic Screening Tool). The proposed rule also included a similar option and many commenters supported it (see *e.g.,* Exs. 30–3344, 30–3745, 30–3749).

OSHA believes that this option should help to reduce burdens for employers while at the same time ensuring that the analysis of risk factors exposure in the job is accurately characterized and not underestimated. Some commenters, including Anheuser-Busch and United Parcel Service reported that they had dozens to hundreds of employees in their establishments who perform the same job (Exs. 32–241). This option also should help establishments employing telephone operators, customer service representatives, catalog sales representatives, data processors, trash collectors, warehouse selectors, grocery store cashiers, meatpackers, poultry processors and others. Including every employee in these ''same jobs'' in the job hazard analysis may be unnecessarily resource intensive, especially where the workstation layouts and tools are identical (Ex. 500–145). Employers may be able to identify the problem and possible controls after analyzing the jobs of only a handful of employees.

This option will also help in situations where jobs are of short duration or do not have fixed workstations (*e.g.,* visiting nurses, home health aides, home repairmen, furniture movers, beverage delivery, package delivery, utility line workers, trash collectors) (Exs. 30–339–22, 30-3714, 32–234–2–1, 500–73, 500–147–33, Tr. 14300). Changes in job locations and job conditions may make it very difficult to analyze the job of each employee. However, analyzing the job for a sample of employees allows employers to identify the MSD hazards facing all of the employees.

OSHA is requiring employers to sample those employees with the greatest exposure to the relevant risk factors to ensure that exposure levels in the job are characterized accurately. OSHA has used the concept of ''representative sampling'' for hazard identification purposes in several of its standards, such as the asbestos standard (29 CFR 1910.1001), the formaldehyde standard (29 CFR 1910.1048), and the lockout/tagout standard (29 CFR 1910.147). The principle behind this concept is that, if the job hazard analysis (or the exposure monitoring, in the case of chemical exposures) reveals that the exposures to this group of most highly exposed workers are not at levels of concern, it is likely that those of other lesser exposed workers will also not be of concern.

A few participants disagreed that the representative sampling option would be useful to reduce burdens for employers:

> OSHA concedes that ''conducting a job hazard analysis that covers all employees in a problem job may be burdensome'' * * * It is not possible for an employer to know of and account for the multitude of physical factors that affect the way its employees work. A sample selected, for instance, could inadvertently ignore the employee with the widest fingers, the smallest feet or the most sensitive hearing, in violation of the proposed rule. OSHA's ''shortcut'' for performing a job analysis is to us insignificant and illusory—employers will, in practice, have to observe virtually every employee in the problem job—a task that even OSHA admits can be burdensome (Ex. 500–197).

OSHA does not believe that employers will have difficulty identifying the employees in a job who are most likely to have the greatest exposure to the risk factors. The specific criteria in the Basic Screening Tool will be particularly useful in helping employers identify, for example, those employees who:

• Repeat the same motion for the longest continuous period during the workshift;

• Lift the heaviest objects or packages or the most objects per workshift;

• Have the greatest degree of flexion or extension of their wrists;

• Use vibrating hand tools for the most time during the workshift; and

• Make the longest reaches during the workshift.

In addition, the body location component in the Basic Screening Tool will help employers identify whether particular physical capabilities, limitations and characteristics may be relevant in selecting the sample of employees for the analysis. For example, employers do not need to consider the width of employees' fingers when it is kneeling or squatting for more than 2 hours that has triggered the need for job hazard analysis. And foot size is not relevant when the risk factors being addressed are vibration, intensive keyboarding, or high hand force.

Moreover, once the people responsible for conducting job hazard analyses have been trained in the hazard identification and job hazard analysis process, their knowledge of ergonomic risk factors and the causes of MSDs will help them determine which employee physical capabilities and limitations may be relevant. They will understand that, if the relevant risk factor is awkward posture associated with bending down to monitor a gauge positioned close to the floor, the employees with the greatest exposure would be those who are taller. And if the risk factor is awkward posture caused by reaching above the head, then shorter employees and those with short reaches would be the most exposed.

Risk Factors

Paragraph (j)(2)(ii) requires employers to identify the risk factors present in the job and to evaluate their magnitude, frequency, and duration. These risk factors include force, repetition, awkward postures, vibration, and contact stress. Unlike the proposal, the final rule does not include cold temperature and static postures as independent risk factors. In addition, contact stress and vibration are defined somewhat more narrowly than they were in the proposal. 64 FR 65808.

Force. Force refers to the amount of physical effort that is required to accomplish a task or motion. Force also refers to the degree of loading to muscles and other issues as result of applying force to perform work. Tasks or motions that require the application of higher force place higher mechanical loads on muscles, tendons, ligaments, and joints (Ex. 26–2). Tasks involving high forces may cause muscles to fatigue more quickly. Some commenters were unclear about the meaning of fatigue in the context of MSDs (see, *e.g.,* Ex. 30–3866). The common use of fatigue, of course, is as a synonym for ''tired.'' However, ergonomics has its roots in engineering, where fatigue has a meaning closer to ''breaking point,'' as in metal fatigue. In other words, fatigue, when used in the context of ergonomics, generally means that the muscle is no longer able to work and must be allowed to recover, or that the point of damage or deformation of a tissue has been reached. Thus, in ergonomics, the term implies more than simply being tired or uncomfortable. The force required to complete a movement increases when other risk factors are also involved. For example, more physical effort may be needed to perform tasks when the speed or acceleration of motions increases, when vibration is present, or when the task also requires awkward postures. Hand tools that require use of pinch grips require more forceful exertions to manipulate the tool than do those that permit use of power grips.

Force can be assessed qualitatively or quantitatively. Quantitative measures include strain gauges, spring scales, and electromyography to measure muscle activity. A qualitative assessment of force is based on direct observation of the amount of physical exertion required to complete a task, and is usually graded on an ordinal scale (*i.e.,* low, medium, high).

Repetition. Repetition refers to the frequency with which a task or series of motions is repeated over and over again with little variation in movement. When motions are repeated frequently (*e.g.,* every few seconds) for prolonged periods such as several hours or an entire work shift, fatigue and strain of the muscle and tendons can occur because there may be inadequate time for recovery. Repetition often involves the use of only a few muscles and body parts, which can become extremely fatigued even though the rest of the body is unaffected.

Repetitive motions occur frequently in manufacturing operations where production and assembly processes have been broken down into small sequential steps, each performed by different workers. Repetition is also present in many manual handling operations, such as warehouse operation and baggage handling. Repetition is typically assessed by direct observation or videotaping or as a percent of task cycle time, where a cycle is a pattern of motions.

Awkward postures. Awkward postures are positions of the body (*e.g.,* limbs, joints, back) that deviate significantly from the neutral position [9] while job tasks are being performed. For example, when a person's arm is hanging straight down (*i.e.,* perpendicular to the ground) with the elbow close to the body, the shoulder is in a neutral position. However, when employees are performing overhead work (*e.g.,* installing or repairing equipment, grasping objects from a high shelf) their shoulders are far from the neutral position. Other examples include wrists bent while typing, bending over to grasp or lift an object, twisting the back and torso while moving heavy objects, and squatting. Awkward postures often are significant contributors to MSDs because they increase the exertion and the muscle force that is required to accomplish the task, and compress soft tissues like nerves, tendons, and blood vessels. As used in the final rule's basic screening tool, awkward postures may be either static postures held for prolonged periods of time, or they may occur repetitively.

Awkward posture is the primary ergonomic risk factor to which employees are exposed when the height of the working surfaces is not correct. Working in awkward postures increases the amount of force needed to accomplish an exertion. Awkward postures create conditions where the transfer of power from the muscles to the skeletal system in inefficient. To overcome muscle inefficiency, employees must apply more force both to initiate and complete the motion or exertion. In general, the more extreme the postures (*i.e.,* the greater the postures deviate from neutral positions), the more inefficiently the muscles operate and, in turn, the more force is needed to complete the task. Thus, awkward postures make forceful exertions even more forceful, from the standpoint of the muscle, and increase the amount of recovery time that is needed.

Awkward postures are assessed in the workplace by observing joint angles during the performance of jobs tasks. Observed postures can be compared qualitatively to diagrams of awkward postures, such as is done in many job analysis tools, or angles can be measured quantitatively from videotape recordings.

Contact stress. Contact stress results from activities involving either repeated or continuous contact between sensitive body tissue and a hard or sharp object. The basic screening tool in the final rule includes a particular type of contact stress, which is using the hand or knee as a hammer (*e.g.,* operating a punch press or using the knee to stretch carpet during installation). Thus, although

[9] Neutral posture is the position of a body joint that requires the least amount of muscle activity to maintain. For example, the wrist is neutral in a handshake position, the shoulder is neutral when the elbow is near the waist, and the back is neutral when standing up straight.

contact stress is covered in the final rule as a single risk factor, it is really a combination of force and repetition. Mechanical friction (*i.e.,* pressure of a hard object on soft tissues and tendons) causes contact stress, which is increased when tasks require forceful exertion. The addition of force adds to the friction created by the repeated or continuous contact between the soft tissues and a hard object. It also adds to the irritation of tissues and/or to the pressures on parts of the body, which can further inhibit blood flow and never conduction.

Contact stress commonly affects the soft tissue on the fingers, palms, forearms, thighs, shins and feet. This contact may create pressure over a small area of the body (*e.g.,* wrist, forearm) that can inhibit blood flow, tendon and muscle movement and nerve function. The intensity of exposure to contact stress is usually determined qualitatively through discussion with the employee and observation of the job.

Segmental vibration. Vibration refers to the oscillatory motion of a physical body. Segmental, or localized vibration, such as vibration of the hand and arm, occurs when a specific part of the body comes into contact with vibrating objects such as powered hand tools (*e.g.,* chain saw, electric drill, chipping hammer) or equipment (*e.g.,* wood planer, punch press, packaging machine). Although using powered hand tools (*e.g.,* electric, hydraulic, pneumatic) may help to reduce MSD risk factors such as force and repetition, the tools can expose employees to vibration. Vibrating hand tools transmit vibrations to the operator and, depending on the level of the vibration and duration of exposure, may contribute to the occurrence of hand-arm vibration syndrome or Raynaud's phenomenon (*i.e.,* vibration-induced white-finger MSDs) (Ex. 26–2).

The level of vibration can be the result of bad design, poor maintenance, or the age of the powered hand tool. For example, even new powered hand tools can expose employees to excessive vibration if it they do not include any devices to dampen the vibration or in other ways shield the operator from it. Using vibrating hand tools can also contribute to muscle-tendon contractile forces owing to operators having to use increased grip force to steady tools having high vibration.

Vibration from power tools is not easy to measure directly without the use of sophisticated measuring equipment. However, vibration frequency rating are available for many recently designed hand tools.

Exposure to a single ergonomic risk factor may be enough to cause an MSD incident. For example, a task may require the exertion of so much physical force that, even though the task does not involve additional risk factors such as awkward postures or repetition, an MSD is likely to occur. For example, using the hand or knee as a hammer (*e.g.,* operating a punch press or using the knee to stretch carpet during installation) alone may expose the employee to such a degree of physical stress that the employee has a significant risk of a serious injury.

Generally, however, ergonomic risk factors act in combination to create an MSD hazard. Evidence in the Health Effects section (Section V) shows that jobs that involve exposure to multiple risk factors are likely to cause MSDs, depending on the duration, frequency and/or magnitude of exposure. Thus it is important that ergonomic risk factors be considered in light of their combined effect in causing or contributing to an MSD. This can only be achieved if the job hazard analysis and control process includes identification of all the ergonomic risk factors that may be present in a job. If all of the risk factors are not identified, employers will not have the information that is needed to determine the cause of the MSD incident or understand what risk factors need to be controlled to eliminate or reduce the MSD hazard in the job.

Based on its review of the scientific literature available at the time of the proposal, OSHA also identified prolonged sitting and standing (a form of static posture) and whole-body vibration as risk factors for MSDs; in addition, OSHA identified cold temperatures as a risk factor because it could require workers to increase the force necessary to perform their jobs (such as having to grip a tool more tightly) (64 FR 65808). The final rule does not explicitly include these risk factors. For prolonged standing and sitting, and for cold temperatures, although there is evidence of an increased risk of MSDs with exposure, the available evidence did not permit the Agency to provide sufficient guidance to employers and employees on the levels of exposures that warrant attention. For whole-body vibration, there was substantial evidence of a causal association with low back disorders (*e.g.,* see NIOSH 1997); however, heavy equipment and trucks, the most common sources of whole-body vibration, are seldom rated for vibration frequencies and intensities. In addition, measurement of whole-body vibration levels requires special equipment and training that would be difficult for most employers to obtain. Therefore, OSHA determined that it was appropriate not to include whole-body vibration in the final rule at this time.

Cold temperatures can, however, increase the effect of other risk factors. By reducing the dexterity and sensitivity of the hand, cold temperatures may cause a worker to apply more grip force to hold hand tools and objects. Also, prolonged contact with cold surfaces (*e.g.*, handling cold meat) can impair dexterity and induce numbness. Cold air blowing from a pneumatic tool, or a draft from the HVAC system, also can result in localized cold stress on the hands, arms, neck, or shoulder. Cold also increases the effects of vibration, such as in tree felling and cutting to length with a chainsaw on a cold day.

Performing a job hazard analysis includes determining the magnitude, frequency, and duration of employee exposure to the risk factors described above. These terms are discussed below.

Duration. Duration refers to the cumulative time an employee is exposed to one or more risk factor(s). The duration of exposure has a substantial effect on the likelihood of both localized tissue fatigue and general cardiovascular fatigue. (Again, the word "fatigue" is used in the ergonomics sense.) In general, the longer the period of continuous work (*i.e.*, the longer the task requires sustained muscle contraction), the longer the recovery or rest time required (Ex. 26–2). Changing the sequence of activities or the recovery time and pattern of exposure may mitigate the effects of long duration. Breaks or short pauses in the work routine help to reduce the effects of prolonged exposure.

Frequency. Frequency refers to the number of times the exposure is repeated within some unit of time, in contrast to duration, which relates to the cumulative length of exposure. This factor also can be obtained by observing and counting (either by video tape, in person, or mechanically) the number of repetitions or the cycle time associated with each task. The response of muscles and tendons to work is dependent on the number of times the tissue is required to respond and the recovery time between these responses. The frequency of an activity can be measured at the micro level, such as grasps per minute or lifts per hour. However, there are some tasks, such as lifting a 150-pound package or pushing a 400-pound beer barrel, where simply knowing that the activity occurs, say, on one day every week, is sufficient to establish that an MSD hazard is present.

Magnitude is a measure of the strength of the risk factor; for example: how much force, how deviated the posture, how great the velocity or acceleration of motion, how much pressure due to compression. Magnitude can be measured either in absolute terms or relative to an individual's capabilities. There are many qualitative and quantitative ways to determine the magnitude of exposure to ergonomic risk factor(s) (some of these measurement tools are provided in Appendix D–1). In relatively simple cases, one approach is to ask employees to classify the force requirements or physical difficulties posed by the job on a scale of 1 to 5, or on a scale as simple as ''low,'' ''medium,'' and ''high.'' When magnitude is assessed qualitatively, the employee is making a relative rating, *i.e.*, is rating the perceived magnitude of the risk factor relative to his or her own capabilities. Relative ratings can be very useful in understanding whether the job fits the employees currently doing the job.

There are a number of ways to measure the magnitude of exposure quantitatively (see, *e.g.,* Exs. 500–218, 500–220). For example, the NIOSH Lifting Equation is widely used to determine recommended weight limits for safe lifting and carrying (see, *e.g.*, Exs. 26–521). The Snook Push-Pull Tables are also used by many employers to evaluate and design pushing, pulling and carrying tasks (see, *e.g.*, Ex. 26–1008). For work-related upper extremity MSDs the Rapid Upper Limb Assessment (RULA) evaluation tool is often used to investigate and evaluate jobs (see, *e.g.*, Ex. 26–1421). These three tools are included in Appendix D–1, and are discussed at greater length in connection with that Appendix.

Paragraph (j)(3)

Paragraph (j)(3) of the final rule requires the employer to use one of the following methods or tools to conduct the job hazard analysis:

a. One or more of the hazard identification tools listed in Appendix D–1 of this section, if the tools are relevant to the risk factors being addressed; or

(ii) The occupation-specific hazard identification tool in Appendix D–2 of this section; or

III. A job hazard analysis conducted by a professional trained in ergonomics; or

(iv) Any other reasonable method that is appropriate to the job and relevant to the risk factors being addressed.

The final rule, like the proposal, requires employers to evaluate the ergonomic risk factors they have identified to determine whether the employee's exposure to them is the result of an MSD hazard or hazards in the job. To make this determination, employers must look at the duration, frequency and magnitude of the ergonomic risk factors in the job, as required by paragraph (j)(3). This evaluation may allow the employer to rule out some risk factors that do not pose a significant risk of injury, as well as to identify risk factors that do rise to the level of an MSD hazard. Risk factors are sometimes ruled out because the exposure does not last long enough, is not repeated frequently enough, or is not intensive enough to pose a risk. On the other hand, a job that requires significant bending from a neutral posture for most of the day would be identified as an MSD hazard by the appropriate hazard identification tool in Appendix D–1, and the job would therefore be labeled a ''problem job,'' as noted in paragraph (j)(4) of the standard.

The approach to hazard identification reflected in paragraph (j)(3) of the final rule differs from the proposed approach and responds to comments that objected to the proposed approach (see, *e.g.*, Exs. 32–300–1, 30–3032). The proposal included a table that listed 20 physical work activities and job conditions such as ''exerting considerable physical effort to complete a motion'' and ''using hand and power tools,'' linked each of these activities to a number of risk factors likely to be associated with the performance of such activities, and directed employers to evaluate these risk factors to determine whether an MSD hazard was present.

The National Telecommunications Safety Panel was one of many participants who found the proposed hazard identification approach unhelpful:

> The members of the Panel strongly believe that the matrix of ''physical work activities and conditions'' and ergonomic risk factors that may be present * * * provides insufficient guidance to be included as a mandatory item in a federal rule. (Ex. 30–3745).

A similar comment was that the proposed job analysis approach shifted the burden of hazard identification from OSHA to the employer (Ex. 30–4334). Commenting on this point, however, the AFL–CIO stated:

> * * * the obligation placed upon employers in the proposed ergonomics standard, as with other standards, is to eliminate or reduce an occupational hazard. In the proposed ergonomics standard, OSHA has defined ''hazard'' not in numerical terms but in descriptive terms: ''MSD hazards are physical work activities and/or physical work conditions,'' in which ergonomic risk factors are present, that are reasonably likely to cause or contribute to a covered MSD (Ex. 500–218).

Other commenters argued that the proposed approach to the identification of risk factors and MSD hazards was vague and that OSHA should instead provide a permissible exposure limit (PEL) for each risk factor and each possible combination of risk factors (see, *e.g.*, Exs. 500–197, 30–2435, 30–973, 30–1274, 30–2426, 30–1350, 30–2428, 30–3986, 30–3993, 30–3000, 30–3086). Since some employers have been very successful in using simple approaches, such as the one proposed, to identify and control MSD hazards, however, OSHA finds this argument unpersuasive. Risk factors and MSD hazards are being identified and addressed in thousands of workplaces every day, and employers and employees are using a wide variety of approaches to do so.

OSHA recognizes, however, that although certain of the risk factors described above are easy to identify and understand, others are not as apparent or observable. Employers who already have ergonomics programs and persons who manage ergonomics programs generally have no difficulty identifying risk factors in the workplace, because they have learned to look for them (see, *e.g.*, Exs. 30–3755, 500–220, 32–359–1, 32–210–2, 32–198–4, 30–3805, Tr. 11427). Because these individuals have training and experience, ergonomic risk factors are familiar concepts for them. Through the process of developing and implementing their ergonomics programs, these individuals have gained a good working knowledge of the ergonomic risk factors that are most likely to be present in their workplaces. For those employers who are just beginning their programs and have little or no training and experience dealing with ergonomic risk factors, OSHA has tried in the standard to make the process of identifying them as straightforward and easy as possible. For this reason, OSHA has provided employers with many different hazard identification tools in mandatory Appendix D–1 and mandatory D–2.

The large number of risk evaluation tools in the record and the many comments OSHA received on the proposed list of physical activities and conditions have led the Agency to include in the final rule several options for hazard identification that employers may choose from. Many commenters discussed hazard identification tools that are currently used by employers (see, *e.g.*, Exs. 500–200, 500–218, 30–3813, 30–276). Thus, the final rule allows a choice of hazard identification approaches, including simple checklists, more structured assessment tools, and reliance on expert consultants.

The United Automobile Workers (UAW) submitted a number of checklists that its members use (Exs. 32–185–3–26, 32–185–3–33), and described several approaches to hazard identification that employers have used to identify ergonomic risk factors effectively (Ex. 500–220). These approaches include:

• Development of consistent methods to measure the physical stresses on the body. Stress is determined by the force exerted on a body part, the frequency of the motion and the posture of the joint. The Force-Frequency-Posture paradigm is common to both expert and checklist approach to ergonomics analysis.

• Development of simplified non-expert approaches to measurement of risk factors (checklists)

• Formulation of the NIOSH lifting guide and related biochemical models which take into account the weight of an object, distance from the body and motion of the body in lifting.

• Validation of symptom surveys and discomfort surveys (psychophysical measures) as risk factor identification tools

• Validation of the use of risk factor checklists and symptom surveys by workforce personnel to identify high risk jobs and propose abatement methods.

Dr. Don Chaffin, founder of the Center for Ergonomics at the University of Michigan, testified that the precision of many tools used to evaluate risk factors is very high (Tr. 8255–8286). Ms. Lisa Brooks, corporate ergonomist for International Paper, commented that there were many different analysis tools used throughout the company (Tr. 11427).

The AFL–CIO also commented on the widespread availability of risk factor evaluation tools (Ex. 500–218):

> Testimony and evidence in the record demonstrate the job analysis tools such as the NIOSH Lifting Equation and Snook—Ciriello Push-Pull Tables are widely utilized by employers, unions, consultants and others to evaluate exposure to ergonomic risk factors throughout a wide range of industries and businesses. Representatives of International Paper (Tr. 11425–26), Owens-Corning (Tr. 10856), Conti Group Corp. (Tr. 10788), Coca Cola (Tr. 14356) and Levi Strauss (Tr. 14710) testified that they routinely used these tools in their ergonomic programs to analyze jobs for ergonomic risk factors. Representatives from the UAW and UNITE! testified how these and other tools such as UAW–GM Check Lists were used by employers and union representatives to evaluate ergonomic hazards at Ford (Ex. 32–185–3–42; 46, Tr. 5827, 5828), GM (Tr. 5831), Maytag (Tr. 8062), VF Corp. (Tr. 7074), Owens-Corning (Tr. 10858), Levi Strauss (Tr. 14710), Coca Cola (Tr. 14356), PPG Industries (Tr. 3131).

OSHA has included several of these tools in Appendix D–1.

Paragraph (j)(3)(i)

Paragraph (j)(3)(i) of the final rule allows the employer to evaluate ergonomic risk factors using one or more of the hazard identification tools listed in Appendix D–1 of this section. Appendix D–1 list eight hazard identification tools: (1) The Job Strain Index (Ex. 26–883), (2) the NIOSH lifting equation (Ex. 26–572), (3) the UAW–GM checklist (Ex. 32–185–3–26), (4) the applicable ACGIH threshold limit values for physical agents (Exs. DC 389, 500–166–1, 502–273), (5) the Rapid Entire Body Assessment (REBA) (Ex. 500–121–26), (6) the Rapid Upper Limb Assessment (RULA) (Ex. 26–1421), (7) Appendix B to the final Washington State ergonomics standard (WAC 296–05174) (Ex. 32–210–2–99), (8) the Snook Push/Pull Hazard Table (Ex. 26–1008). Tools selected must be relevant to the risk factors being addressed. This means, for example, that an employer could not use the NIOSH Lifting Equation, which is appropriate for employees exposed to certain types of force, to analyze a job involving repetition and awkward posture.

A number of participants submitted evaluation tools to the record (see, *e.g.,* Exs. 26–2, 26–5, 32–77–2–1, 502–67, 26–883, IL–162–Q, 32–185–3–31, 500–142–12, OR–348–1, 32–185–3–26, 500–121–61, 38–260, IL–218, IL–228, 32–339–1–82, DC 417–6, 500–121–21, 38–93, 500–121–28, 32–111–1, 32–198–4–27–1), while others (see, *e.g.,* Exs. 500–220, 500–218, Tr. 5567) suggested that the final rule include tools, such as the Snook tables and the OSHA *Meatpacking Guidelines* (Ex. 30–2387). Still other participants merely asked the Agency to provide more guidance in the final rule for companies to identify ergonomics risk factors (see, *e.g.,* Exs. 30–276, 30–3818, 30–4290, 500–197, 500–218, 30–3864, Tr. 11601, Tr. 9070, Tr. 17419), and many commenters suggested that OSHA provide non-mandatory checklists (see, *e.g.,* Exs. 30–3765, 30–1671, 30–3284, 30–2387, 32–300–1, 30–519, 30–4844, 30–3032, 30–3748, 30–3813).

Based on this evidence, OSHA has decided to allow employers to demonstrate compliance with paragraph (j)(3) by using one or more of the tools in Appendix D–1, assuming it is appropriate to the risk factors being addressed for job hazard analysis purposes. These hazard identification tools were suggested by several commenters (see, *e.g.,* Exs. 30–276, 32–339–1, 500–218, 30–3813, 500–220, 30–3361, 30–2134, 32–210–2, 32–210–2, Tr. 5567, Tr. 8706, Tr. 10629, Tr. 16487). For example, Marathon Oil stated:

> Since the proposed rule is job-based (particularly targeted to problem jobs), OSHA should have reviewed the scientific literature to identify and publish exposure assessment methods capable of distinguishing problem jobs from non-problem jobs. In its proposed rule, OSHA fails to mention existing methods capable of such prediction (*e.g.* the Strain Index) or methods that have the potential for such predictions (*e.g.* the Revised NIOSH lifting equation) (Ex. 30–3361).

OSHA selected the tools in Appendix D–1 for several reasons. They were developed by professionals who have extensive training and experience in the identification, analysis and control of MSD hazards. For instance, the Snook Push/Pull Hazard Table was developed by Dr. Stover Snook , a certified professional ergonomist with a PhD. in experimental psychology, who has spent 38 years researching MSDs and 25 years teaching ergonomics at the Harvard University School of Public Health (Ex. 37–6).

The eight tools in Appendix D–1 are also well-documented. They are based on scientific evidence on the relevant risk factors, and most been published in peer-reviewed scientific journals (*e.g.,* Job Strain Index, NIOSH Lifting Equation, RULA, REBA, Snook Push/Pull Hazard Table). To illustrate, the steps in the Job Strain Index by Moore and Garg were based on the findings and data of a number of peer-reviewed studies, including the Borg CR–10 scale (Ex. 26–883). The summary and explanation of Appendix B to the Washington State Ergonomics Standard includes extensive discussion and tables documenting the scientific support for each element in that tool (Ex. 32–210–2–99).

The tools have also been tested, most of them extensively. For instance, to develop the Rapid Entire Body Assessment (REBA) tool, three ergonomists/physiotherapists independently coded 144 posture combinations and then incorporated the sensitizing concepts of load, coupling and activity scores to produce the final REBA score, with accompanying action levels (Ex. 500–121–26). Thereafter, two workshops were held involving 14 occupational safety and health processionals (including ergonomists, occupational therapists, physiotherapists and nurses) to code more than 600 additional samples of postures from several industries (*i.e.,* health care, manufacturing and electrical) in order to further refine the REBA scores. There was between 62 to 85% agreement among the 14 professionals (Ex. 500–121–26).

Dr. Snook testified at the hearing about the years of extensive testing he did to develop the Push/Pull Hazard Table:

> Most of my experiments were psychophysical investigations of manual handling tasks, viz., lifting, lowering, pushing, pulling, and carrying. The purpose of these experiments was to collect hard data for use in evaluating the risk of manual handling tasks, and to aid in the redesign of these tasks. At the time, psychophysics was the only method that could yield usable data for task evaluation. Psychophysics is a very old method that is concerned with the mathematical relationship between sensation and their physical stimuli. Psychophysics has been applied to practical problems in many areas, including the decibel scale of loudness, and ratings of perceived exertion (RPEs) * * *
>
> My colleagues and I conducted eleven major manual handling experiments over a period of 25 years [citations omitted]. Each experiment lasted two to three years. These experiments were unique in hat they used realistic manual handling tasks performed by industrial workers (68 males and 51 females) over long periods of time (at least 80 hours of testing each subject). Physiological measurements of oxygen consumption and heart rate were recorded for comparison with psychophysical measurements. The experimental design also included 16 to 20 hours of physical conditioning and psychophysical training. A battery of 41 anthropometric measurements were recorded for each subject to insure that the sample was representative of the industrial population. The results of these experiments were combined and integrated into tables of maximum acceptable weights and forces for various percentages of the working population (Ex. 37–6).

These tools were also designed for use by persons with only minimal training in hazard identification. For example, Washington State said that it designed Appendix B particularly for small employers with limited resources who wanted ‘‘maximum clarity and certainty.’’ Washington State Appendix B includes illustrations of the relevant risk factors and a simple 5-step process for determining whether particular lifting tasks pose a hazard. The other tools in Appendix D–1 use similar approaches. For instance, the GM–UAW checklist uses a simple stars and checks approach to those tasks and activities that may warrant further investigation or controls.

Finally, OSHA has selected these eight tools because they all include specific and well-defined recommended criteria for when employers need to take action and when no further action would be necessary. As such, these tools address commenters' arguments that the standard must provide clear guidance to employers in identifying risk factors and knowing when they have done enough to control them (see, *e.g.,* Exs. 30–276, 30–3818, 30–4290, 500–197, 500–218, 30–3864, Tr. 11601, Tr. 9070, Tr. 17419). These tools specifically and clearly operationalize the table of physical work activities and conditions in the proposed rule so they answer commenters' repeated questions about what proposed terms such as ‘‘over and over,’’ ‘‘considerable physical effort,’’ ‘‘long reaches’’ and ‘‘heavy’’ objects mean. For example, the Job Strain Index (Ex. 26–883) defines ‘‘over and over’’ in terms of efforts per minute (number of exertions/total observation time). The NIOSH Lifting Equation defines a ‘‘heavy’’ object as weighing 51 pounds or more, and then shows users how to reduce the amount of weight that can be lifted within the equation's limits on the basis of particular conditions in the workplace.

There are tasks for which each of the evaluation techniques in Appendix D–1 are well suited and tasks where the tool is not appropriate. The following information explains the limits and appropriate uses for each tool in Appendix D–1.

Job Strain Index

The Job Strain Index is designed to identify jobs associated with MSDs of the hand. It does this by measuring or estimating six task variables: intensity or exertion, duration of exertion per cycle, efforts per minute, wrist posture, speed of exertion and duration of task per day (Ex. 26–883). The Job Strain Index and documentation supporting it was published in a peer-reviewed scientific journal.

Area of the body covered by the Job Strain Index: Hand/wrist.

Risk factors evaluated: Force, awkward postures, repetition (speed of work).

Examples of jobs that Job Strain Index is applicable to or well-designed for: Jobs involving high hand repetition, small parts assembly, keyboarding, inspecting (assembly line), sorting, meatpacking, sewing, packaging.

NIOSH Lifting Equation

The NIOSH Lifting Equation, which is already widely used, was developed to evaluate manual lifting demands. It provides an empirical method for computing a weight limit for manual lifting tasks to prevent or reduce the occurrence of lifting-related low back pain among workers. Six factors are used to determine the recommended weight for the specific working conditions: horizontal distance, vertical distance, travel distance, frequency, twist, coupling. Then the actual weight is compared with the recommended weight to determine the ‘‘allowable’’ lift index. The NIOSH Lifting Equation and documentation supporting it has been published in a peer-reviewed scientific journal.

Area of the body addressed by NIOSH Lifting Equation: Lower back.

Risk factors evaluated: Force (distance, coupling), repetition (frequency), awkward postures (location of the object, travel distance, twist).

Examples of jobs that NIOSH Lifting equation is applicable to or well-designed for: manual handling tasks involving objects weighing more than 10 pounds; forceful lifting tasks in production and assembly work; package sorting, handling, delivery and pickup.

ACGIH TLV Hand/Arm (Segmental) Vibration TLV

The ACGIH Hand/Arm (Segmental) Vibration TLV describes how to measure hand tool vibration and provides threshold limit values for exposure.

Areas of the body addressed: Hands, Arms/Shoulders.

Risk factors evaluated: Vibration.

Examples of jobs that the Hand/Arm (Segmental) Vibration TLV is applicable to or well-designed for: Jobs involving use of powered and vibrating hand tools (*e.g.,* grinding, sanding furniture, sawing, jigsawing, chain saws).

GM–UAW Checklist

The UAW–GM checklist was developed to evaluate a range of risk factors in production jobs. The checklist uses checks (√) and stars (*) to indicate whether the certain activities and conditions are present for less than or more than one-third of the production cycle or workday. The number of checks and stars, in conjunction with the report of an MSD, is used to determine if the job requires further investigation or control action.

Areas of the body addressed: Hand/wrists, Forearms/elbows, Shoulders, Neck, Back/Trunk, Legs/knees.

Risk factors evaluated: Force (including manual handling), Repetition, Awkward Postures (including Static Postures), Vibration, Contact stress

Examples of jobs that the GM–UAW checklist is applicable to or well-designed for: cyclical production and assembly work jobs.

RULA

The Rapid Upper Limb Assessment (RULA) was developed to evaluate ergonomic exposures of the upper body. The range of motion for each body part (upper arms, lower arms, wrists, neck) is rated based on the amount of posture deviation. Posture combinations are ranked to reflect musculoskeletal loading with force, static work and repetition factors. RULA and documentation supporting it has been published in a peer-reviewed scientific journal.

Areas of the body addressed: Wrists, Forearms/elbows, Shoulders, Neck, Trunk.

Risk factors evaluated: Awkward posture, force, repetition.

Examples of jobs that RULA is applicable to or well-designed for: assembly and production work, janitorial and maintenance, meatpacking, restaurant, grocery cashier, telephone operator.

REBA

The Rapid Entire Body Assessment (REBA) is similar to RULA, but it has been modified to be more useful for the working postures found in the health care and other service industries. REBA and documentation supporting it has been published in a peer-reviewed scientific journal.

Areas of the body addressed: Wrists, Forearms/elbows, Shoulders, Neck, Legs/knees, Trunk, Back

Risk factors evaluated: Awkward posture, force (load and coupling), repetition.

Examples of jobs that REBA is applicable to or well-designed for: Patient lifting and transfer, assembly and production work, janitorial and maintenance work, meatpacking, restaurant work, grocery cashier, telephone operator.

Washington State Appendix B

The Washington State Appendix B was developed to determine if jobs that were in the Washington State ''caution zone'' actually pose an MSD hazard to employees in them. The checklist shows physical risk factors and lists duration (from 2 to 6 hours) by body part. If the work activities or conditions apply, the job poses an MSD hazard.

Areas of the body: Shoulders, Neck, Back, Trunk, Knees, Forearms, Wrists, Hands, Elbows.

Risk factors evaluated: Awkward postures, Force (including manual lifting and high hand force), Repetition, Contact Stress, Vibration.

Examples of jobs that Washington State Appendix B is applicable to or well-designed for: very wide range of jobs including patient lifting and transfer, assembly and production work, janitorial and maintenance, meatpacking, restaurant, grocery cashier, telephone operator, keyboarding, manual handling, meatpacking, jobs involving use of powered and vibrating hand tools, janitorial, solid waste.

Snook Push/Pull Hazard Table

The Snook Push/Pull Table is designed to identify whether pushing, pulling and carrying activities meet or exceed established maximum acceptable loads or force levels for those activities. It does this by examining initial and sustained forces of loads, horizontal distance, vertical distance, frequency and object weights. These measurements are compared with the tabled values corresponding to the task and considered acceptable for 75% and 90% of the adult male and female population. The Snook Push/Pull Table and documentation supporting it has been published in numerous peer-reviewed scientific journal articles. In addition, the table was used in developing the NIOSH Lifting Equation.

Body areas addressed: Back/Trunk, Legs, Shoulders.

Risk factors evaluated: Force, repetition, awkward posture.

Examples of jobs that Snook Push/Pull Hazard Table is applicable to or well-designed for: manual handling jobs involving pushing or pulling objects or carrying objects a long distance, and hospital laundry and janitorial jobs, among others.

Paragraph (j)(3)(ii)

Paragraph (j)(3)(ii) allows employers to use the video display terminal (VDT) hazard identification tool in Appendix D–2 of this section for jobs involving risk factors related to computer use. Appendix D–2 is a simple checklist to assess the physical activities and layout of workstations with a VDT. Like the tools in Appendix D–1, the VDT checklist was added to the final rule to address comments that the physical activities and conditions listed in the proposal were too vague to be used for job hazard analysis and control (see, *e.g.,* Exs. 500–197, 30–2435, 30–973, 30–1274, 30–2426, 30–1350, 30–2428, 30–2986, 30–2993, 30–3000, 30–3086, 30–3853, 30–326, 30–546, 30–4189, 30–3845).

The function of the checklist is to determine if the computer workstation and layout address the risk factors most commonly found in VDT jobs. The analyst using this checklist would talk with and observe the worker(s) while they are at the computer workstation. If a condition or activity in the job merits the checklist's ''Yes,'' the analyst would check the ''Yes'' box. If there are no more that two ''No'' answers to the checklist questions, the computer workstation design, layout or equipment needs no further evaluation or control to be in compliance with paragraph (j)(3)(ii).

Intensive computer use accounts for a significant number of MSDs each year and occupational computer use is growing. MSDs associated with computer use are reported in a wide range of industries (*e.g.,* telecommunication, telephone, banking, insurance, catalog and telephone sales, customer service, package delivery service, newspaper) and in businesses of all sizes, including very small establishments. OSHA believes that its VDT checklist provides these businesses with an easy and quick way to identify and control hazards in a large number of jobs.

OSHA designed this checklist after considering the many examples of computer workstation checklists in the record (see, *e.g.,* Exs. 26–2, 26–1517, 26–1337, 32–182–1–6, 502–313–3, IL–258, 500–142–10). The checklist is designed to provide employers with a simple way to identify the five risk factors this standard covers, as they most commonly occur in computer work and workstations. All the employer need do is check whether the risk factor is or is not present in the employee's working conditions and workstation equipment, and address those that are present.

The checklist provides clear and specific guidance in how the employer can provide or adjust a computer workstation so it will be comply with the control requirements of this standard. Each checklist item is written to provide the solution to the problem it identifies. For example, the checklist items addressing awkward neck postures actually show how to position the computer monitor to eliminate those postures (*e.g.,* ''Top line of screen is at or below eye level so employee is able to read it without bending head or neck down/back,'' ''Monitor position is directly in front of employee so employee does not have to twist head or neck,'' ''No reflected glare (*e.g.,* from windows, lights) is present which might cause employee to assume an awkward posture to read screen.'').

OSHA expects the VDT checklist to provide significant assistance for employers in industries where MSD hazards associated with computer use are the major, or even the only, MSD hazards they face. Unlike other checklists in the record, which include a range of risk factors such as vision and general environmental conditions, OSHA's checklist addresses only those risk factors this standard covers. Second, the OSHA VDT checklist is also more flexible than some other checklists in the record because it is risk factor-based rather than equipment-based. In equipment-based checklists, employers get a passing score only if they have purchased and installed particular equipment at each computer workstation. OSHA's risk factor-based checklist, however, gives employers the flexibility of deciding how to best control the identified hazards. For example, an equipment-based checklist asks employers whether they have provided adjustable height tables and monitor risers. A risk factor-based checklist, on the other hand, asks employers whether the employees' heads and necks are in a straight rather than awkward positions (*i.e.,* bent down or back), when they look at the monitor screen. If an employer can achieve this result without purchasing new adjustable equipment, this will satisfy the standard. A number of participants said that they have controlled risk factors at VDT workstations without purchasing new adjustable equipment (see *e.g.,* Tr. 2707).

OSHA stresses that, like the other tools in Appendix D, its VDT checklist is only one of a number of methods employers may use to identify and control MSD hazards related to computer use. Employers are free to use other checklists in the record or to continue using whatever method they currently use to identify and evaluate MSD hazards associated with computer use, provided those methods address the risk factors this standard covers.

Paragraph (j)(3)(iii)

Paragraph (j)(3)(iii) allows employers to choose to have a job hazard analysis conducted by a professional trained in ergonomics. By a ''professional trained in ergonomics,'' OSHA means an ergonomist, safety professional, industrial hygienist, engineer, or other safety and health professional who has received training in the principles of ergonomics and their application in job hazard analysis and control. Reliance on a trained professional or competent person is a concept used in many OSHA rules, such as the Asbestos Standard (29 CFR 1910.1001), the Process Safety Management Standard (29 CFR 1910.119), and the Telecommunications Standard (29 CFR 1910.268).

A few commenters suggested that the final rule should require specific qualifications for those individuals permitted by the rule to perform job hazard analyses (see, *e.g.,* Exs. 30–4674, 32–210–2). OSHA rejected this idea because the record contains many examples of cases where employers and employees are doing an effective job of analyzing their jobs and then controlling them (see, *e.g.,* Exs. 32–377–2–1, 32–111–1, 32–198–4–27–1). In fact, OSHA believes that in about 85% of cases, managers, supervisors, and employees can, with some training in ergonomic principles and job hazard analysis, perform the required analysis of jobs in their workplace that have met the action trigger. Thus, OSHA believes that, in most cases, employers will be able to perform job hazard analyses without expert outside help, and that the sheer number of employers who have already established effective ergonomics programs on their own (Ex. 502–17) is testimony to the ability of companies to initiate a program without hiring a consultant. The record has many comments (see, *e.g.,* Exs. 502–17, 500–215, Tr. 11427, Tr. 1008, Tr. 13764) reporting that employers and employees are ''going it alone.''

The hazard identification method permitted by paragraph (j)(3)(iii), however, is based on the expert judgment of a safety and health professional trained in ergonomics and its application in the workplace. This job hazard analysis option, therefore, assumes that the employer has chosen to seek outside help (unless, of course, the workplace has such a safety or health professional on staff). Paragraph (j)(3)(iii) is unlike paragraphs (j)(3)(i) and (ii) in this respect. OSHA is aware that some employers (see., *e.g.,* Ex. 502–17) currently rely on outside experts or OSHA's consultation program for job hazard analyses. For most employers and most jobs, however, OSHA believes that employers will choose to develop the level of in-house expertise needed to implement the job hazard and control requirements of the standard.

Paragraph (j)(3)(iv)

Paragraph (j)(3)(iv) allows the employer the flexibility to use any other reasonable method of job hazard analysis that is appropriate to the job and relevant to the risk factors being addressed. This method could consist of a hazard identification tool of the type in Appendix D, or of a job hazard analysis methodology developed by the company itself. Many employers utilize trained workplace ergonomic committees to perform these job analyses. OSHA has included this job hazard analysis option in the final rule in recognition of the fact that other hazard identification tools and methods are effective in identifying MSD hazards, and that many employers have instituted effective ergonomic programs that include job hazard analysis methods that do not rely on ergonomist-consultants or on the tools in Appendix D. OSHA does not wish to stifle creativity or to foreclose the option to use existing hazard identification tools or methods that will get the job done.

If employers choose to avail themselves of the option in paragraph (j)(3)(iv), they must be sure that the method of job hazard analysis they choose is one that is reasonable and appropriate for the risk factors present, *i.e.,* the risk factors identified in the job by the Basic Screening Tool. For example, if the job requires the employee to sit in a chair and assemble cellular phones for 8 hours a day, then the method must be appropriate for seated work, hand/arm force, and the motions that are required by the job. A method that only measures strain to the back would clearly not be a reasonable method of job hazard analysis for this phone assembly job. Paragraph (j)(3)(iv) encourages employers to continue to use their own effective analysis techniques, provided they are appropriate, or to develop a tool that fits their needs.

Many participants submitted ergonomic risk factor evaluation tools that they have used in their workplaces to the record (see, *e.g.,* Exs. 26–2, 26–5, 32–77–2–1, 502–67, 26–883, IL–162–Q, 32–185–3–31, 500–142–12, OR–348–1, 32–185–3–26, 500–121–61, 38–260, IL–218, IL–228, 32–339–1–82, DC 417–6, 500–121–21, 38–93, 500–121–28, –3, 32–111–1, 32–198–4–27–1). For example, the Dow Chemical Company uses a method that measures posture, repetition, force and duration and takes into consideration frequency and environmental factors, such as lighting, for computer workstations (see, *e.g.,* Ex. 32–77–2–1). The Dow Chemical method provides for scoring of jobs based on the number of words typed or keystrokes per minute (frequency), the time spent doing the task (duration), and the amount of force or amount of deviated posture (magnitude) used by the worker to perform the task (see, *e.g.,* Ex. 32–77–2–1). The final score on the ''Dow card'' allows the person performing the job analysis (usually the employee in the job) to determine if there is a problem.

The United Steelworkers of America developed a survey as a job hazard analysis tool for bus drivers. The survey includes qualitative measurements of reach distances for the steering wheel, floor pedals, clutch, and door handles, as well as the force required to use work site tools. Seating support and visibility are also evaluated using the tool that has been developed to evaluate exposures for bus drivers see, *e.g.,* Ex. 32–111–1). Levi Strauss uses a checklist with measurements by body part for posture, repetition, duration, force, and allows for other factors, such as the use of PPE, concrete flooring, kneeling, slippery floors, vibration and temperature that might be found in apparel industry jobs (see, *e.g.,* Ex. 32–198–4–27–1). These methods of analysis are applicable to the tasks and work environments for which they were developed because they measure the risk factors that are reasonably expected to be found in those tasks and jobs in their respective industries.

In fact, the record contains many examples of employers who are identifying and controlling ergonomics risk factors on a daily basis. Dow Chemical sites across the country have been recognized by OSHA and the Voluntary Protection Program (VPP) for their outstanding safety and health efforts. Their programs include the analysis of ergonomics risk factors:

> Dow analyzes tasks utilizing a risk evaluation card. This card looks at the various ergonomic hazards that may be present in our workplaces and rates these hazards by a relative risk index or weighting method. This weighting or indexing approach is consistent with other risk indices, which OSHA has supported or recommended. Indexing allows employers like Dow to prioritize its limited safety and health resources in such a way to get the most ''bang for the buck'' not only from an economic perspective concerning appropriate controls, but also from a risk perspective as well. Such an approach has been successful in our workplaces and has been borne out through our experience. Dow's recordable rates and incidence of MSDs are much lower than the general industry experience (Ex. 30–3755).

Employers are free to select the method or tool that best fits their own jobs, workplace conditions, and culture. A job hazard analysis is effective as long as it allows the person who is performing it to determine whether a job has risk factor(s) that rise to the level of an MSD hazard or does not pose an MSD hazard. Some employers reported using simple and fairly informal procedures to identify hazards in a job (see, *e.g.,* Tr. 17353, 2979). This was especially true for employers who have only limited or isolated ergonomics problems.

A job hazard analysis approach used by many employers is the narrative approach. This method of hazard identification is similar to job analyses used to identify other potential safety and health hazards (see, for example, OSHA's Process Safety Management Standard, 29 CFR 1910.119, which allows employers to use this approach). With the narrative approach, the employer and employee discuss the job requirements and the relationship (if any) between the tasks and the reported MSD. Where the problem identified through the narrative approach is easy to identify and control and the establishment has few MSDs, the employer may be able to use the Quick Fix option permitted by paragraph (o). If the Quick Fix method can be used, the employer does not need to continue with the job hazard analysis, although he or she must observe all the steps in the Quick Fix process. For more complex problems and solutions, the employer is required to comply with the requirements of paragraphs (k), (l), and (m) to control the MSD hazard identified.

In other cases, however, the problem may require a more detailed analysis that could involve breaking the task down into its various discrete elements or activities and then identifying and evaluating the extent to which employees are exposed to risk factors in these activities (see, *e.g.,* Ex. 32–210–2). The quantified risk factors are then compared to values that have been shown to contribute to the MSD hazard (*see, e.g.,* Exs. 26–2, 26–1247, 500–121–26, 32–210–2–99, DC–386, 500–121–21).

A job hazard analysis approach that is intermediate between the narrative approach and the detailed analysis discussed above is the use of a checklist. Checklists provide more structure than the narrative approach, but are less time consuming than a detailed job analysis. Several commenters suggested that OSHA include checklists in the standard (see, *e.g.*, Exs. 30–3748, 30–3755, 32–182–1, 30–3826, 30–3818). OSHA agrees that well-designed checklists, when used as intended, can provide an effective hazard identification approach for a range of employers, especially small business owners. There are many ways in which checklists are useful: identifying physical work activities and conditions, identifying ergonomic risk factors, evaluating jobs, prioritizing jobs for further analysis, and providing a method of evaluating the effectiveness of controls. The American Physical Therapy Association (APTA) endorsed the usefulness of checklists as a job hazard analysis option:

> In APTA's review, checklists would be an extremely helpful resource to small businesses conducting job hazard analyses. (Ex. 30–3748).

The following example of a job hazard analysis includes a combination of qualitative and quantitative observations and measurements (Ex. 38–438):

Title: Turkey processing—thigh boning.

Objective: Remove thigh bones from the turkey carcasses.

Standard: 540 thighs deboned per 8-hour shift, 15 minute a.m. break, 30 minute lunch, 15 minute p.m. break.

Workstation: Overhead conveyor, shackles 44 inches above the floor.

Equipment: Thigh boning knife; wire mesh glove for non-knife hand; optional rubber gloves for both hands; hard hat; smock; boots.

Methods: (1) Grasp and position thigh with non-knife hand, (2) Cut along thigh bone to separate meat from bone 2–3 cuts, (3) Cut remaining tendinous attachments (bone drops into conveyor as work release meat and bone.

Environment: Air-conditioned turkey plant; turkeys at 38°F, ambient air 45°F.

Risk Factors:

1. Forceful exertions—(knife hand) holding knife, cutting thighs, (non-knife hand) holding thighs for cutting. Force depends on user's technique, sharpness of the blade, worker's position relative to the moving turkey. Forces on the cutting hand are greater (up to 38 pounds) than the hand holding the thigh (up to 19 pounds). Holding hand is relaxed between cuts, while the knife hand continues to grasp the knife handle (4 pounds).

2. Repetition—4,320 cuts per hour, holding thigh 1,080 times per hour.

3. Awkward/Static posture—Wrist bent and forearm rotated while cutting thighs. The wrist is angled due to the straight knife, type of cut, location and orientation of the turkey.

Paragraph (j)(4) of the final rule simply states that jobs that have been determined, through the job hazard analysis process, to pose an MSD hazard to employees in that job are called ''problem jobs'' for the purposes of the standard.

OSHA finds, based on the comments, data, and other evidence on job hazard analysis in the record, that the job hazard analysis approach adopted in paragraph (j) of the final rule is widely used by employers and employees and is highly effective. Further, the hazard identification tools and methods permitted by this paragraph are commonly used in workplaces large and small, for workers with fixed and mobile worksites, and in the analysis of both traditional and ''non-traditional'' jobs.

Paragraph (k)—What Is My Obligation To Reduce MSD Hazards?

Paragraph (k) of the final ergonomics standard tells employers how far they must go in reducing MSD hazards at the workplace. This paragraph sets the control endpoint that employers must achieve. Final paragraph (k) presents three options. Employers are in compliance with this paragraph when the controls they have implemented:

• Control the MSD hazards to the extent that they are no longer reasonably likely to cause MSDs that result in work restrictions or medical treatment beyond first aid,

• Reduce MSD hazards in accordance with or to levels below those in the hazard identification tools in Appendix D that the employer used to conduct the job hazard analysis, or

• Reduce MSD hazards to the extent feasible.

As described in the Risk Assessment and Economic Analysis sections of this preamble, much evidence in the record demonstrates that employers with existing programs are able to successfully control the MSD hazards in problem jobs to a level where an MSD is reasonably unlikely to occur.

Paragraph (k) of the final rule does not require employers to eliminate all MSDs. OSHA recognizes that, in a number of jobs, workplaces, and physical work activities it may not be possible to eliminate MSDs. OSHA is also aware that employers who have an effective ergonomics program may still receive reports of MSDs. The goal of the final rule is to assure that employers take effective action to control MSD hazards, and paragraph (k) tells employers how far they must go in implementing controls.

Paragraph (k)(1)(i)

An employer is in compliance with paragraph (k)(l)(i) when it reduces MSD hazards to the extent that they are no longer reasonably likely to cause MSDs that result in work restrictions or medical treatment beyond first aid. The hazard analysis conducted under paragraph (j) will have identified the risk factors of concern. To control the MSD hazard, the employer must reduce the magnitude, duration, or frequency of the risk factors to the level where they are reasonably unlikely to cause such MSDs. There are several ways an employer can achieve this goal.

First, the employer can reduce ergonomic risk factors below the levels in the Basic Screening Tool. The final standard recognizes that risk factors below the levels in the screening tool are not reasonably likely to cause MSDs, and allows an employer to discontinue his or her ergonomics program if it has reached those levels.

Second, the employer can otherwise control the hazards such that they are reasonably unlikely to cause MSDs. In some cases, the needed controls may be obvious or readily discoverable by reference to compliance assistance materials. In other cases, judgment may be required. In any event, the employer may refer to the method it used under paragraph (j) to determine whether the job presents a hazard. For example, the employer may use a professional trained in ergonomics to conduct the analysis and determine whether job conditions present a hazard and to recommend measures to control the hazard. The employer can also make use of its own knowledge and experience gained under its program.

The employer may also use hazard identification tools. As described above in the explanation of paragraph (j), the employer may choose from a variety of such tools. Appendix D lists a number of specific tools that provide safe harbors for compliance under paragraph (k)(1)(ii); however, the employer may also consider other tools that are effective in identifying hazardous levels of exposure in determining what controls to implement.

These examples are not intended to be exhaustive. They are intended to illustrate means employers may use to ''control MSD hazards.''

Several points bear noting. First, the obligation is not to reach a level of absolute safety or to assure that no further MSDs will occur: it is to reduce the hazard so that work activities are not reasonably likely to cause MSDs. Second, the hazard reduction is targeted to MSDs that result in work restrictions (including days away from work) or medical treatment beyond first aid. These are serious conditions by any measure. Finally, the standard allows the employer to take up to two years to implement permanent controls. This extended period should be sufficient to allow for situations in which installation of effective controls requires a period of adjustment.

Paragraph (k)(1)(ii)

The second option is to reduce MSD hazards in accordance with or to levels below those in the hazard identification tools in Appendix D that the employer used to conduct the job hazard analysis. This appendix is intended to give employers specific guidance to help them determine whether or not they have gone far enough in controlling MSD hazards. As discussed more fully below, many rulemaking participants felt that the proposed rule was vague and shifted the burden of determining how far to control MSD hazards to employers (see, *e.g.*, Exs. 30–1722; 30–3956, 35–106; Tr. 4110, 15648–15649) or suggested that OSHA provide, in the final rule, more guidance on how to make that determination (see, *e.g.*, Exs. 30–1557, 30–2987, 30–3748, 30–3765, 32–133, 32–300). OSHA has responded to these comments by allowing employers the option of controlling MSD hazards to the specific levels set out in Appendix D.

Paragraph (k)(1)(iii)

Paragraph (k)(1)(iii) of the final rule states that employers are in compliance with the endpoint if they have reduced the hazard to the extent feasible. This paragraph applies when it is not feasible for employers to reach one of the endpoints in paragraphs (k)(1)(i) and (ii). It is included because OSHA has no authority to require employers to do what is not feasible or ''capable of being done.'' *American Textile Mfrs. Institute* v. *Donovan (Cotton Dust)*, 452 U.S. 490, 509, 513 n. 31, 540 (1981). A control that will reduce a hazard in a job is feasible if it is achievable within the limits of current technology and knowledge and the employer's financial resources. An employer's inability to afford controls will not establish infeasibility if its level of compliance lags significantly behind the rest of its industry. See Section IV–A.6.a(4)(a) and (b) of OSHA's Field Inspection Reference Manual (CPL 2.103). See also, *United Steelworkers* v. *Marshall*, 647 F.2d 1189, 1269 (D.C. Cir. 1980).

OSHA is also requiring that employers who meet the compliance endpoint by being at the limits of feasibility, but have not fully controlled MSD hazards, periodically check to see whether new technology has been developed and is available. These checks must be carried out at least once every 3 years. When additional feasible controls are identified, the final rule requires employers to implement them until one of the compliance endpoints given in paragraph (k)(1)(i) or (k)(1)(ii) is reached. Requiring employers to look for and implement new control methodology ensures that an employer who has not fully controlled ergonomic hazards is not relying on obsolete control measures.

What Happens When a New MSD Is Reported After Controls Have Been Implemented?

Paragraph (k)(2) of the final rule tells employers what to do if an employee reports an MSD in a job in which the employer has implemented MSD hazard controls. If an employee makes such a report, the employer must check to see if the controls are still in place and are functioning and being used properly. The employer must also check to see if any new hazards exist that were not present when the job hazard analysis was conducted. The employer need not conduct another full job hazard analysis but may undertake a review of the previous job hazard analysis to determine if it is adequate.

Sometimes, after ergonomic control measures have been implemented in a problem job, another employee will experience and report an MSD. The injury could be a sign that the controls are not functioning correctly or that new hazards have arisen. For example, an employer might have, among other things, installed adjustable keyboard trays at each VDT station and trained employees in their use. If one of the keyboard trays gets out of adjustment, the operator using that tray might experience and report tendinitis in his or her wrists. An employer following paragraph (k)(2) of the final rule would check to ensure that the keyboard tray is still present and is adjusted properly.

Note to Paragraph (k)

A clarifying note at the end of paragraph (k) explains that the occurrence of an MSD in a problem job is not in itself a violation of the standard. This note emphasizes that the focus of the final rule's compliance endpoint is on the control of MSD hazards and not on the elimination of MSDs from the workplace. OSHA recognizes that, for a number of jobs, workplaces, and physical work activities, it may not be possible to eliminate MSDs. OSHA is also aware that employers who have effective ergonomics programs may still receive reports of MSDs. The goal of the final rule is to have employers put a good working system into place so that they can take effective action to control MSD hazards.

The Proposed Rule

The proposed rule would have required employers to meet one of three compliance endpoints:

• Materially reduce MSD hazards in the problem job using the incremental abatement process;

• Reduce MSD hazards in the problem job to the extent feasible; or

• Eliminate MSD hazards in the problem job.

OSHA explained the first endpoint with a definition of ''materially reduce MSD hazards.'' The definition, which was repeated in a note following proposed § 1910.921(a), read as follows: '''Materially reduce MSD hazards'' means to reduce the duration, frequency and/or magnitude of exposure to one or more ergonomic risk factors in a way that is reasonably anticipated to significantly reduce the likelihood that covered MSDs will occur.''

The following paragraphs discuss the comments, evidence, and testimony received on the proposed compliance endpoint and present OSHA's reasons for accepting or rejecting the rulemaking participants' suggestions and for including the final rule's compliance endpoint requirements.

1. Comments That the Proposed Compliance Endpoint Was Vague

Many of the comments and much of the testimony OSHA received on the issue of compliance endpoints stated that the language used to set compliance goals was vague and confusing (see, *e.g.,* Exs. 30–333, 30–1722, 30–2208, 30–2387, 30–3765, 30–3813, 30–3853,30–3956, 30–4185, 30–4334, 30–4467, 32–300, 32–337, 440, 500–118, 500–188, 500–197, 500–221; Tr. 2960, 4109, 14986). In particular, these rulemaking participants argued that the related terms ''material reduction or elimination of MSD hazards'' and ''materially reduce the MSD hazards'' were so vague that employers would not know how far they had to go to control MSD hazards. For example, ORC said that those terms, together with the phrase ''reasonably anticipated to significantly reduce the likelihood'' in the clarifying note following § 1910.921(a), would prove to be compliance nightmares for employers and enforcement nightmares for OSHA (Ex 30–3813, 32–78). ORC claimed that the language in the note would breed unnecessary confusion. Further, Edison Electric Institute stated that the definition of ''materially reduce MSD hazards'' uses three terms, ''reasonably,'' ''significantly,'' and ''likelihood,'' that are themselves vague (Ex. 32–300). Several rulemaking participants believed that this vagueness would lead to unnecessary litigation (see, *e.g.,* Exs. 30–3813, 30–3956, 30–4185, 30–3853, 32–337). James Lancour, representing EEI, was concerned that the vagueness would cause employers difficulty in program and training development, stating:

> To provide reasonable program development and training one must clearly define the program endpoints and the steps to achieve these endpoints. The endpoints must also be objectively measurable to achieve the desired results. This proposed standard is so vague and ambiguous that neither the endpoints nor the measurement criteria are specifically defined.
>
> How does one develop an ergonomic program, give guidance in determining compliance and provide general and specific training to facility program facilitators, managers and supervisors and employees when the terms of compliance are so poorly defined? [Tr. 2897]

Some rulemaking participants argued that OSHA left the word ''feasible'' undefined (see, *e.g.,* Exs. 30–3956, 30–4334; Tr. 14986). For example, United States Senator Kit Bond observed that OSHA ignored comments from the Small Business Advocacy Review panel about the vagueness of the word ''feasible'' (Ex. 30–4334). The National Coalition on Ergonomics (NCE) stated that the lack of a suitable definition rendered the option to ''implement controls that reduce the MSD hazards to the extent feasible'' unclear (Ex. 30–3956). The Coalition said that OSHA had not provided any reliable guidance as to what ''feasible'' meant from either a technological or an economic standpoint. The Coalition believed that this left employers with no way of determining whether a particular hazard control was feasible for them.

Paul, Hastings, Janofsky, and Walker LLP also argued that the proposed standard's attempt at flexibility resulted in a standard using terminology full of ambiguity (Ex. 30–3231). The law firm believed that OSHA's enforcement staff would likewise struggle to understand the rule.

The National Coalition on Ergonomics (Ex. 30–3956) went further to suggest that the proposed language was so vague as to be unconstitutional:

> It is fundamental that ''a statute which either forbids or requires the doing of an act in terms so vague that men of common intelligence must necessarily guess at its meaning and differ as to its application, violates the first essential of due process of law.'' Connally v. General Constr. Co.. 269 U.S. 385, 39 (1926). [Footnote omitted.] Thus, an occupational safety and health standard must give an employer fair warning of the conduct it prohibits or requires, and it must provide a reasonably clear standard of culpability to circumscribe the discretion of the enforcing authority and its agents. Dravo Corp. v. OSHRC, 613 F.2d 1227, 1232, 7 BNA OSHC 2089 (3d Cir. 1980). [Footnote omitted.]
>
> * * * * *
>
> The language and terminology used by OSHA in much of the proposed standard and Preamble is so vague and ambiguous that it fails to provide employers with adequate notice of what the standard will require and prohibit and, accordingly, is unconstitutionally vague. The proposed standard fails to provide employers with adequate notice as to the conditions, circumstances or activities in the workplace that cause MSDs and what employers must do to eliminate MSDs under the standard.
>
> The following is a partial list of terms which are either vague and/or undefined and fail to provide employers with notice of the required performance under the standard—''material reduction or elimination of MSD hazards * * *'' and ''ergonomic hazard.'' These terms are so ambiguous as to fail to provide employers * * * notice of what is required with respect to the fundamental provision of feasible control measures. [Ex. 30–3956]

The AFL–CIO (Ex. 500–218) believed that the proposed standard was clear and that employers would be able to successfully carry out the obligations imposed by it. The union countered some of the vagueness arguments in its post-hearing submission:

Employers must control exposure to ergonomic risk factors to the point that covered MSDs are no longer ''reasonably likely to occur,'' in other words, to eliminate the ''MSD hazard,'' or reduce it to the extent feasible. * * *

The record demonstrates that employers will be able to accomplish this task. Utilizing various tools and other available guidance, employers have been able to measure and evaluate exposure to ergonomic risk factors and identify and implement controls to reduce those exposures. There is plentiful testimony in the record demonstrating that employers are able to ascertain conditions that present an ergonomics hazard and to identify and implement measures to reduce or eliminate the hazard.

* * * * *

The proposed standard is clear, and with the inclusion of the AFL–CIO's recommendations, will be even clearer, that an employer's obligation extends only to eliminating hazardous exposures at work. An employer's obligation to conduct job analysis and institute controls applies only where there is exposure on the job to an ergonomic risk factor or risk factors that occurs at a sufficient level of duration, intensity, or magnitude to present a risk of MSDs. Under OSHA's proposed screening criteria, an employer is only required to conduct a job analysis if there are ''physical work activities and conditions in the job'' that are ''reasonably likely to cause or contribute to the type of MSD'' being addressed, and ''[t]hese activities and conditions are a core element of the job and/or make up a significant amount of the employee's worktime.'' * * * If these screening criteria are not met, the occurrence of an MSD does not trigger any obligations on the employer's part. And the proposed standard limits an employer's control obligations to situations where there is substantial exposure to ergonomic risk factors on the job. If the employer's job analysis does not show the existence of a hazard, *i.e.,* exposure to ergonomic risk factors that are reasonably likely to cause or contribute to a covered MSD, the employer is under no obligation to institute controls. The standard clearly limits employers' obligations to situations where there is significant exposure in the workplace, and limits employers' obligations to addressing hazardous exposures at work. [Ex. 500–218]

Dr. Frank Mirer of the UAW also believed the proposed rule was clear based on General Duty Clause ergonomic settlement language that was similar to that in the proposal (Tr. 5932).

OSHA does not agree that the language of the proposed rule was impermissibly vague. Nevertheless, OSHA has changed the compliance endpoints to respond to the vagueness comments and provide greater clarity. OSHA believes that the language of the final rule's three endpoints gives employers clear and understandable guidance as to what they must do. Employers who achieve the objective ''safe harbor'' endpoints in Appendix D are assured they are in compliance. This avoids the problem most frequently raised by commenters: That the proposal did not give employers objective criteria by which to measure their compliance obligations. The objective criteria in the Basic Screening Tool give employers an alternate clear means of assuring they are in compliance. OSHA has also sought to clarify the general performance terms like ''MSD hazard'' and ''control MSD hazards'' used in the standard. OSHA has clarified that an employer may rely on a safe-harbor hazard identification tool, a professional consultation, or any other reasonable method to define whether a hazard exists requiring control. OSHA has also dropped terms, like ''incremental abatement process'' and ''material reduction,'' that commenters asserted were especially unclear.

a. *Comments that the language used in the proposed standard is so vague and subjective that it would lead to uneven enforcement.* Some rulemaking participants who claimed the proposed endpoints were vague were also concerned about the possibility that the alleged vagueness would lead to uneven enforcement (see, *e.g.,* Exs. 30–333, 30–1274, 30–3765, 30–3839, 30–3845, 30–4185, 440, 500–188, 500–197; Tr. 3330, 5439, 7211, 17891). They believed that the proposed definition of ''materially reduce'' and the corresponding explanation of that term in the preamble to the proposal would call for subjective judgments and would lead to disagreements between employers and OSHA enforcement staff. For example, The Forum for a Responsible Ergonomics Standard stated:

Enforcement of the proposed ergonomics program standard would require a degree of subjectivity in determining compliance unprecedented in the Agency's history. This is because of the nature of the area regulated combined with the vagueness of the proposed standard's requirements.

For example, proposed Section 1910.921 (a) provides that employers are in compliance if they implement controls that ''materially reduce'' MSD hazards in the job * * * OSHA recognizes that ''a number of MSD hazards are complex and it may not always be clear what control(s) will achieve a material reduction in the probability that MSDs will occur.'' * * * In an attempt to clarify what constitutes compliance with this requirement, OSHA then proposes that employers will be considered in compliance ''if they select and implement the controls that a reasonable person would anticipate would achieve a material reduction in the likelihood of injury.'' * * * However, the ''reasonable person'' standard is hardly a bright-line means of determining whether an OSHA inspector will find an employer in compliance.

This is only one example of how compliance with the proposed standard, at best, is dependent on interpretations of vague standards by OSHA inspection officials—individuals, at least to date, with little or no training in ergonomics, who inevitably will establish differing criteria to be applied to employer efforts in this area. [Footnote omitted.] This approach invites litigation over the meaning of such vague terms. Indeed, the ''reasonable person'' is a long-standing standard of tort law used by juries to assess the culpability of an individual; by its nature, it is open to interpretation.

Forum members fear that the vagaries of complying with the proposed standard may be held against them during the OSHA inspection process. By leaving too much to interpretation and failing to provide significant guidance, inspectors may be able to cite facilities despite their good faith efforts to comply. The lack of compliance guidance potentially is a fundamentally fatal flaw with OSHA's mandatory proposed standard and must be addressed by OSHA before a reasonable standard can be promulgated. [Ex. 30–3845]

The National Association of Manufacturers' post-hearing submission (Ex. 500–1) contained a letter from Scott Ward of Windings, Inc. Mr. Ward presented an analogy with how an existing performance standard is enforced. He described an example of how the existing standard on personal protective equipment has led to disagreements with OSHA's compliance staff and a citation:

[W]e provided gloves and design changes to a material (woven fiberglass tape) to reduce an irritation—not even a hazard, for there is no injurious nature to the material—and re-assigned an employee who suffered the most irritation so as to not aggravate a skin condition. However, a field inspector cited us for lack of an effective program even though we had reviewed the material's MSDS, provided the recommended (not required) personal protection equipment, accommodated employee's complaints and the inspector's own testing indicated that the fiberglass dust was well below exposure level limits. We had begun work on ventilation equipment to provide extra equipment and this engineer, who doesn't have air fluid dynamics training, said it wouldn't work. The citation was reduced but it stood. [Ex. 500–1]

OSHA received comments and testimony that the training of its field staff would significantly affect the reasonableness of the Agency's compliance efforts (see, *e.g.*, Ex. 30–

1107; Tr. 5439, 7210). William Goldsmith, representing the U.S. Chamber of Commerce, was particularly concerned that the lack of training of OSHA field staff would lead to enforcement difficulties:

And it also bears noting that the companies at least the ones that I am familiar with involved in these cases had ergonomics programs. Dayton Tire did. Hudson Foods did. So when one looks at the past history of what has happened with trying to enforce the terms and the concepts that are ripe throughout this proposed standard, you I think get a fair picture of what will happen if the proposed standard becomes a final rule.

That is a compliance officer doing the best he or she can will come into a facility, will probably not be not very well trained through no fault of his own or indeed the agency's own, but because resources are limited, be making guesses as to what ergonomics stressors appear in what jobs and the litigation if that is what it is, if that is where results will begin. [Tr. 7210]

In their post-hearing submission, the Chamber noted that the American Society of Safety Engineers (at Tr. 11616) and the AFL–CIO (at Tr. 3498) agreed that training of OSHA's compliance staff would be crucial to the enforcement of the ergonomics standard (Ex. 500–188). The Chamber doubted, however, that such training would be successful:

Thus, it is beyond dispute that additional training is required. Of course, it is difficult to understand how the Agency will successfully provide such training since * * * even the individuals who drafted the Proposed Rule do not know what it means. [Ex. 500–188]

Craig Brightup of the National Roofing Contractors' Association, which was concerned about the impact on small businesses, expressed similar concerns:

OSHA's lack of enforcement restraint, coupled with the vagueness of the ergonomic standard, would be a disaster for small business. Chairman Talent stated in his comments, and I quote, ''Instead of developing a standard that gives small businesses guidance and assistance in implementing physical changes to the workplace that reduce and eliminate MSDs, OSHA has left it up to employers to figure out how to prevent or eliminate MSDs. These vast regulatory crevices into which small businesses will inevitably fall will be filled by the unfettered discretion of OSHA inspectors as they determine compliance. (Tr. 3330)

Edison Electric Institute noted the possibility that compliance officers would second guess employers' decisions on control measures (Ex. 32–300). The Center for Office Technology was similarly concerned that the ''subjective terms 'reasonable' and 'likelihood' make it impossible for either the employer or the OSHA inspector to know when an employer is in compliance [Ex. 30–2208].''

Some rulemaking participants went further, arguing that the vague language in the proposal forces employers to make subjective judgements about whether they have gone far enough to control hazards (see, *e.g.,* Exs. 30–3853, 30–3956, 32–337, 500–27; Tr. 6219). The Integrated Waste Services Association and the National Coalition on Ergonomics (citing *AFL–CIO* v. *OSHA,* 965 F.2d 962 (11th Cir. 1992) at 976) stated that this is in conflict with the requirements of section 6(b)(5) of the OSH Act for the Agency to set standards using objective criteria. The Coalition stated that the Agency cannot expect an employer to decide about permissible exposure to MSD hazards when OSHA is unwilling or unable to make that determination.

Mr. Edward C. Laux of the International Cemetery and Funeral Association believed that the term ''to the extent feasible'' was subjective and would present compliance difficulties for employers. Mr. Laux compared compliance under the proposal's requirement to control MSD hazards to the extent feasible with the reasonable accommodation test in Title I of the Americans with Disabilities Act:

[Section 1910.921] provides that businesses must eliminate or materially reduce musculoskeletal disorder (MSD) hazards in the workplace ''to the extent feasible.'' This highly subjective standard presents difficulties of interpretation similar to the ''reasonable accommodation'' test in Title I of the Americans with Disabilities Act (ADA).

The ADA ''reasonable accommodation'' test at 42 U.S.C. 102(b)(5) and at 1630.9 of the U.S. Equal Employment Commission regulations requires employers to make alterations in the workplace for disabled workers unless the accommodation would impose ''undue hardship'' on the covered business. Interpretation of the terms ''reasonable accommodation'' and ''undue hardship'' must be made on a case-by-ease and business-by-business basis. As a result, interpreting these ADA terms has been the subject of administrative appeals and expensive litigation of which small businesses, in particular, are ill-equipped to afford.

The ICFA believes that the ''feasibility'' provision at 1910.921 of the proposed Ergonomics programs will result in similar conflicts of interpretation that cannot be resolved in a ''one size fits all'' application. Small businesses, which comprise 87 percent of the cemeteries and funeral homes in the United States, will be confronted by OSHA inspectors second-guessing their understanding of this vague provision and imposing fines on these businesses where they disagree with their judgment.

At that point, small businesses will be forced to choose between two highly unattractive alternatives: either to pay expensive penalties for noncompliance with a vague and subjective standard or to hire expensive lawyers to appeal and litigate the fines. The litigious history of similar language in the ADA removes any doubt that this scenario as applied to the Ergonomics standard is not only probable but certain. [Ex. 500–27]

b. Comments that the vagueness of the rule is compounded by the lack of scientific certainty. Some rulemaking participants argued that the lack of guidance was compounded by the scientific uncertainty of whether a given control measure would abate the hazards (see, *e.g.,* Exs. 30–294, 30–461, 30–494, 30–1722, 30–2986, 30–3853, 32–337, 500–197; Tr. 3232, 11375). For example, the U.S. Chamber of Commerce stated, ''At first glance, the 'reasonableness' element of these definitions seems to provide an employer a certain amount of leeway in eliminating or reducing the hazards. This, however, is not the case. Under current scientific principles, nobody knows the point at which the likelihood of an MSD occurring will be reduced.'' The Chamber alleged that OSHA's experts admitted as much. The Chamber quoted small portions of two OSHA expert witnesses in *Secretary of Labor* v. *Hudson Foods* and *Secretary of Labor* v. *Dayton Tire* to support this point. The Chamber suggested that the witnesses could not quantify the reduction in the rate of MSDs resulting from a given control measure. The Chamber concluded:

These statements were made, it bears repeating, by people called by OSHA in litigated matters to support particular ergonomics allegations individuals whom, presumably, OSHA believed qualified enough to sponsor as experts at trial. Yet neither of them could support the efficacy of their particular recommended abatements in a particular workplace cited for particular violations of the General Duty Clause. Nevertheless, somehow OSHA expects employers * * * even small employers like the overwhelming majority of the Chamber's members * * * to develop their own effective control measures.

Although OSHA has shifted to the employer the burden to identify to what degree a ''risk factor'' must be reduced to prevent an MSD from occurring, that is a question nobody can answer. Indeed, OSHA concedes that ''[b]ecause of the multifactoral nature of MSD hazards it is not always clear whether the selected controls will achieve the intended reduction in exposure to MSD hazards.'' 64 Fed. Reg. at 65827. Furthermore, in some cases, particular ergonomic controls may cause more harm than good. 64 Fed. Reg. 65827 ''[m]any employers evaluate controls within 30 to 60 days after implementation. This gives employees enough time to get accustomed to the controls and to see whether the controls have introduced other problems into the job.'' (emphasis added). Because no one, including OSHA, is equipped to identify at what point an MSD is less likely to occur or to identify which abatement measures are effective in reducing such likelihood, this requirement is flawed beyond repair. [Ex. 30–1722]

The National Coalition on Ergonomics (Ex. 500–197) echoed the Chamber's point and argued that the rulemaking record demonstrated a lack of consensus regarding what control measures would be effective in reducing the rate of MSDs:

Ergonomics experts likewise admit the impossibility of predicting with any degree of accuracy the ergonomic modifications that will successfully reduce musculoskeletal complaints. [Footnote omitted.] In fact an expert testifying for OSHA in a general duty clause enforcement action said he would need a ''crystal ball'' to determine whether a particular abatement measure would eliminate ergonomic stressors.[10] [Footnote: Transcript, April 6, 2000, at 7191–92. In March of 1999, an expert ergonomist hired by OSHA in another matter confessed that there is simply no way to predict in advance the outcome of a particular abatement measure. He testified that it is impossible for an employer to know ahead of time whether a control measure will materially reduce or even reduce at all the rate of musculoskeletal complaints. Transcript, April 6, 2000, at 7194.] The lack of consensus regarding appropriate ergonomic interventions among the people who ultimately would be relied on to implement the proposed rule surfaced repeatedly in the hearings. The hearings also revealed the highly uneven track record of ergonomic interventions in the workplace and the consistent inability of ergonomics professionals to measure the effects of ergonomic interventions, or to predict when a particular intervention will be effective in controlling or abating targeted musculoskeletal complaints. [Ex. 500–197]

The Coalition further contended that no consensus exists as to who is best situated to identify effective ergonomic solutions (Ex. 500–197). The Coalition noted that some ergonomics professionals testified that employees are the best persons to identify controls but that others, including one of OSHA's expert witnesses, occupational health professionals, and employees themselves, stated that employees did not have the expertise necessary to identify control measures. NCE concluded this argument by stating: ''OSHA has put the cart before the horse in promulgating a rule that requires employers to produce solutions that reduce ergonomic hazards when no available or reliable means exist for predicting or measuring the efficacy of ergonomic interventions.''

LPA, Inc., also objected to the proposed control endpoints because ergonomics is not an exact science (Ex. 30–494). LPA noted that the studies on which NIOSH and OSHA relied did not provide sufficient information to employers so that they could evaluate jobs, assess exposure to risk factors, and select controls that will eliminate the risk factors.

The Honorable David McIntosh, Chairman of the House Subcommittee on National Economic Growth, Natural Resources, and Regulatory Affairs, noted that even OSHA admits that most ergonomic fixes are not 100 percent effective (Ex. 30–542, 30–3010). He wrote:

A second problem is the lack of end points or clear criteria for determining when an employer has fulfilled his obligations. OSHA is an enthusiastic proponent of ergonomic ''solutions.'' But even OSHA admits that most ergonomic fixes are not 100 percent effective. [Footnote omitted.] For example, in shoe manufacturing, installing armrests and footrests, elevation and tilt equipment, better designed chairs, and pallet levelers to minimize bending while lifting reduced the ''number of damaging wrist motions in assembly jobs by one-third,'' reduced ''disc compression forces in clerical jobs by about 17 percent,'' and reduced ''disc compression forces during lifting jobs by more than 50 percent.'' [Footnote omitted.] Such workstation modifications undoubtedly reduce the risk of MSDs. But, suppose another MSD occurs after the employer has implemented those changes. What is the employer's obligation? Must he experiment with more engineering options? Must he slow the pace of work, or implement a job rotation system? [Footnote: ''The answer appears to be 'yes.' Here is the regulatory language: '[Y]ou must continue this incremental abatement process if other feasible controls are available' (1910.922(c)).''] How practical would that be in a small establishment? What if the only way to eliminate damaging wrist motions and disc compression forces is to eliminate the jobs that require wrist flexion and bending while lifting?

An employer can only guess when his efforts to reduce MSDs are adequate in OSHA's eyes, because the rule contains no outcome performance measures or benchmarks. Reducing MSDs by 50 percent or even 70 percent below current levels is no guarantee that an employer has done enough. Nor is it clear that reducing MSDs 50–70 percent below national average rates for particular kinds of jobs assures compliance with the rule. As long as MSDs occur, an employer remains vulnerable to legal challenge by his employees and OSHA. Yet eliminating all MSDs is beyond any employer's technical and financial resources. To say nothing of the fact that ergonomic ''science'' is still in its infancy, many MSDs are caused or aggravated by activities—sports, yard work, a second job—that may be completely outside an employer's control. The proposed rule thus gives OSHA an open-ended pretext to inspect, cite, and prosecute American companies. [Ex. 30–542]

Mayville Engineering Company, Inc.(Ex. 30–294) noted that it had difficulty applying controls to abate ergonomic hazards without having MSD symptoms surface in previously unaffected employees:

We had a facility that had 10 identical workstations that assembled radiator cores. We had 3 individuals, within a month, report MSDs. The three individuals had worked at these workstations less [than] 1 year. One of the individuals had only been doing this job 6 months. The other individuals working at the other 7 workstations had been working on these jobs from 3–10 years each and had not reported any MSD symptoms. During the hazard evaluation we questioned the 7 as to any problems they had with the workstations and they felt that the workstations were fine the way they were.

We made modifications to all 10 of the workstations based on the MSDs reported. The other 7 individuals started to report MSD symptoms with in 3 weeks. How would this be addressed in your Proposed Standard? [Ex. 30–294]

The National Coalition on Ergonomics noted that the hearing transcript included evidence of other similar instances that the Coalition claimed showed that ergonomic interventions were either ineffectual or created more problems than they solved (Ex. 500–197). On this point, NCE cited the experience of an office that handles 9–1–1 calls, a municipal solid waste department, the Social Security Administration, the Communications Workers of America, and Levi Strauss and Company. The Coalition also cited a passage from Dr. Emil Pascarelli's book, *Repetitive Strain Injury: A Computer User's Guide:* ''All the ergonomic equipment in the world won't prevent RSI unless people who use computer keyboards learn how to type safely, pace themselves, and care for their upper bodies.''

Ms. Lisa Brooks, testifying on behalf of International Paper Company, stated that the current science of ergonomics did not support interpreting the proposed standard consistently for a particular job or task (Tr. 11375). She

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[10] The full text of the transcript cited in the Coalition's footnote reads as follows:

''With respect to all of your proposed abatements, proposed possible solutions, as you call them, that if every single one were implemented with respect to every single job, there would still be ergonomic stressors in every single job?''

Answer, ''I don't know if there still would be ergonomic stressors in every single job, but there might be ergonomic stressors in some jobs, but I can't say that there still would be ergonomic stressors in every single job. No, sir, I cannot say that.''

What would it take for you to say one way or another whether that would be so?''

Answer, ''A crystal ball.''

It is clear from this exchange that the witness was talking about more than one control measure being applied to more than one job.

noted specifically that two lifting guides, Liberty Mutual's manual handling tables and the 1991 NIOSH lifting equation, provide different levels of acceptable risk. She was concerned that, if an employee's condition did not improve after applying the more liberal of the two guides, OSHA would force an employer to use the more conservative even though both are nationally recognized. Ms. Brooks argued that the language in the proposal left the employer in doubt:

Would the determination of the compliance end point change if the injured employee's condition did not improve?

The answer to this question depends upon the interpretation of reasonably likely to occur and significantly reduce the likelihood for a particular job or task.

Some could argue that since the injured employee's condition did not improve, the facility only materially reduced the musculoskeletal disorder hazards at the facility and that the facility must continue in the incremental abatement process and implement additional feasible controls.

Once in the incremental abatement process, the compliance end point becomes tied to the recuperation of an individual. [Tr. 11377]

Ms. Brooks concluded by urging OSHA to postpone the promulgation of the ergonomics standard until it could be written so that compliance can be consistently and objectively measured (Tr. 11381).

c. *Comments that OSHA has not provided sufficient guidance for employers to comply with the proposed standard's compliance endpoint.* Many rulemaking participants were concerned that the proposed standard and the preamble discussion of the regulatory text provided little hazard control guidance for employers (Ex 30–1536, 30–1722, 30–3813, 30–3845, 30–3956, 30–4185, 32–300, 35–106, 500–197). Some were concerned that employers, particularly small ones, would not have the resources to implement the requirements in the proposed standard or to make the judgments it calls for (see, *e.g.,* Exs. 30–1536, 30–2834, 30–3077, 30–3348, 30–3751; Tr. 3330, 8226). These commenters argued that this would force many employers to hire an expert.

Some rulemaking participants believed that OSHA should provide additional guidance for the terms and concepts used in this part of the standard (see, *e.g.,* Exs. 30–1557, 30–2987, 30–3748, 30–3765, 32–133, 32–300). For example, ORC and Edison Electric Institute urged OSHA to include a nonmandatory appendix listing risk factors and examples of acceptable controls (Ex. 32–300). The American Association of Occupational Health Nurses urged OSHA to provide clarification for situations in which MSDs are still being reported after all feasible controls have been implemented (Ex. 30–2387). Dow Chemical Company suggested that the Agency could put appendix-like material on its Web site (Ex. 30–3765). Dow also asked for guidance on the type and amount of improvement that was expected under the incremental abatement process and on the amount of time that was allowed to pass between incremental abatement measures. The American Health Care Association recommended defining ''feasible'' and better explaining the term ''materially reduce'' (Ex. 30–2987). At the hearing, Frank White described ORC's position as follows:

How do I know when I've achieved compliance? Now I understand that OSHA struggles with this issue, but the proposed sections 921 and 922 we believe are off the mark.

In ORC's opinion, the difficulty of establishing precise exposure response relationships between the particular health effects being regulated and a specific workplace risk factors that allegedly cause those condition does not relieve OSHA of the [basic] obligation to provide some quantitative guidance to employers on a point at which significant risk is substantially reduced.

Only in this way will an employer be able to determine whether taking action to control particular workplace risk factors is likely to materially reduce the risk of the specific musculoskeletal disorder that has occurred. [Tr. 4109]

The American Industrial Hygiene Association (AIHA) supported the proposed standard's performance-based compliance endpoint (Ex. 32–133). However, AIHA also believed that OSHA should provide additional guidance. The Association stated:

AIHA supports the fundamental performance-related elements of the proposed ergonomics standard.

The requirement to eliminate or materially reduce ergonomic problems to the extent feasible is a valid performance criterion. Similarly, the ''incremental abatement process'' is performance-based and recognizes the complex nature of ergonomic problems.

Whether a risk-based approach is considered or not, OSHA should add some appropriate examples of risk assessments so that employers can utilize appropriate guidelines and have an idea of what compliance officers will be looking for. OSHA should recommend a variety of risk assessment approaches and describe how enforcement of the standard will take place. [Ex. 32–133]

The Employment Policy Foundation suggested that OSHA include a detailed table to serve as a guide to compliance and to facilitate verification of the Agency's cost estimates (Ex. 30–1557). The Foundation argued that each of the major compliance elements involves several subsidiary compliance tasks. The Employment Policy Foundation provided a table of the tasks that it believed the standard required and recommended that OSHA include one like it in the final rule. The Foundation's table included not only compliance endpoint-related tasks, but tasks related to all aspects of the standard.

d. *OSHA's response to these comments.* In response to the many commenters arguing that the proposed compliance endpoints were too vague and failed to give adequate notice to employers, would lead to uneven enforcement, OSHA has added objective compliance endpoints to the final rule. The three acceptable endpoints are: (1) Control of MSD hazards, (2) reducing MSD hazards in accordance with or to levels below those in the hazard identification tools in Appendix D that the employer used to conduct the job hazard analysis, and (3) controlling hazards to the extent feasible. The Agency has explained each of these options above.

The second compliance endpoint, reducing MSD hazards in accordance with or to levels below those in the hazard identification tools in Appendix D, provides objective criteria to help employers attain an endpoint. In Appendix D–2, OSHA is providing a chart outlining reasonably objective measures of acceptable levels of ergonomic risk factors for VDT operations. In Appendix D–1, OSHA is referencing existing tools that employers are currently using to identify and control ergonomic risk factors. OSHA believes that these tools will provide employers with a bright line method against which they can judge whether their compliance efforts meet the final standard's compliance endpoint.

The employer also has the option ''to reduce MSD hazards to the extent that they are no longer reasonably likely to cause MSDs that result in work restrictions or medical treatment beyond first aid.'' OSHA is providing sufficient guidance, in the preamble, appendices to the standard, and compliance assistance materials, to help employers understand and follow this compliance endpoint. The employer will have to use some judgment and will need to be knowledgeable about the relationship between risk factors and the different types of MSDs when using this endpoint. Many rulemaking participants presented examples of measures they have used to adequately control ergonomics hazards (see, *e.g.,* Exs. 32–274, 500–6, 500–12, 500–50; Tr. 8557, 8579, 11533, 12564, 14972). They clearly understood what needed to be done to control the hazards and where to find the tools to accomplish that goal.

The extensive scientific basis for OSHA's standard is discussed in the Health Effects and Risk Assessment sections of this preamble. However, it is not necessary for an employer to have a complete grasp of ergonomics science in order to comply with the final rule. Many witnesses testified that they had little or no difficulty in addressing jobs successfully (See, *e.g.,* Ex. 32–274; Tr. 11532, 12461, 14708, 14836, 15046), and OSHA has given employers extensive flexibility in addressing these hazards, together with many tools and models to use. In addition, many problems and solutions are readily apparent after observing a job and talking with employee. The availability of professionally-developed tools and the compliance assistance tools being provided by the Agency will also help employers select appropriate control measures to reduce MSD risk factors sufficiently. These risk reductions will lead to a corresponding reduction in the incidence and severity of MSDs at the workplace.

With respect to Mayville Engineering Company's and the National Coalition on Ergonomics' comments that efforts to control MSD may create other MSD hazards and lead to more injuries, OSHA notes that it is possible for certain interventions to increase some risk factors at the expense of the ones an employer is trying to control. However, it does not automatically—or normally—follow that decreasing the duration, frequency, or magnitude of one risk factor will increase another. If that were the case, ergonomic intervention studies, such as those depicted in the Risk Assessment section of the preamble, would be very infrequent, rather than the norm for those employers making a good faith effort at addressing these hazards. It should also be noted that in one of the cases cited by the Coalition, the employer saw an overall decrease in the number of MSDs from the control measures, and further measures were taken to lower the risk factors causing the new MSDs (Tr. 17822 [11]). In another case, a company representative testified that the company ''put in place a wide variety of effective controls'' (Tr. 14706).

Thus, OSHA has concluded that the final rule's endpoint is scientifically sound and will help reduce the number and severity of MSDs in the workplace.

OSHA agrees with commenters, like the National Coalition on Ergonomics, the AFL–CIO, and the American Society of Safety Engineers (Tr. 3498, 7210, 11616), who stated that enforcement of the final ergonomics standard will necessitate extensive training of the Agency's compliance staff. OSHA compliance officers will need to be educated in the requirements of the standard, signs and symptoms of MSDs, ergonomic risk factors, and appropriate control measures, among other things, so that the Agency can enforce the standard in a uniform and reasonable manner. Such training, based on the final standard and on the compliance guidelines contained in this preamble and the appendices to the final rule, is currently being developed and will be provided before the compliance deadlines in the standard.

2. Comments on Whether the Proposed Compliance Endpoint Would Illegally Delegate Rulemaking Responsibility

a. *Comments that the proposed rule would shift the burden of determining the compliance endpoint to employers.* Some rulemaking participants objected that the vagueness inherent in the proposed language shifted much of the burden placed by the OSH Act on OSHA to employers (see, *e.g.,* Exs. 30–1722; 30–3956, 35–106; Tr. 4110, 15648–15649). The U.S. Chamber of Commerce argued that the proposal left to employers the determination of the safe exposure level and the appropriate controls (Ex. 30–1722). Even though it recognized that the proposed standard properly allowed the employer flexibility, the Chamber stated that the proposal went too far:

> Under the Proposed Rule, it is up to the employer to do the Secretary's job of setting a standard that ''most adequately assures, to the extent feasible, * * * that no employee will suffer material impairment of health or functional capacity,'' 29 U.S.C. § 655(b)(5), from exposure to perceived ergonomic hazards. It is the employer that must determine when an employee is at risk from hazards that are ''reasonably likely to cause or contribute to MSD[s].'' Proposed §§ 1910.917, 1910.944, 64 Fed. Reg. at 65832. 65864. And it is up to the employer to determine any combination'' controls either to eliminate the hazards or to at least reduce them ''to the extent feasible.'' Proposed §§ 1910.917, 1910.920(a), 64 Fed. Reg. at 65803, 65828. While the Preamble contends that [t]here are many qualitative and quantitative ways to determine the magnitude of exposure,'' * * * the Proposed Rule fails to set objective levels at which an employer would be required to act. Moreover, the Proposed Rule fails to identify specific measures that an employer must implement to control these supposed hazards. The Act requires the Secretary to make these decisions * * * which the Secretary concedes are impossible to make * * * and not simply to foist that obligation on the regulated community under threat of considerable civil penalties and compliance costs. [Ex. 30–1722]

The National Coalition on Ergonomics made a similar point:

> The proposed standard is so vague and ambiguous that arguably, through its adoption, OSHA will have shifted the burden of identifying the hazard (which is clearly OSHA's duty) and the appropriate response to the hazard (which is also clearly OSHA's duty) to employers. At the same time, the proposed standard fails to clearly state or place meaningful boundaries on what may be required by enforcement personnel to such [a] degree that, if adopted, the standard would represent an unconstitutional delegation of authority from Congress to OSHA. [Ex. 30–3956]

OSHA believes that the final standard is sufficiently clear to inform employers of their obligations, and therefore does not place impossible burdens on employers. The final rule gives employers options. Employers may, but are not required, to use the objective criteria in Appendix D to determine the hazard control level. The rule also gives employers the flexibility to use alternate performance-based measures.

b. *Comments that the proposed rule would shift the burden of determining feasibility and compliance endpoints to OSHA compliance staff.* The American Iron and Steel Institute (AISI) stated that the proposed standard improperly delegated rulemaking authority to OSHA's compliance staff (Ex. 500–223). AISI contended that the proposed rule was equivalent to requiring each employer to issue an unlimited number of blank checks for ergonomic control measures and allow OSHA to fill in the amounts. The Institute argued: ''The mere possibility that the proposed standard is written in such a way as to permit OSHA to adopt * * * an unreasonable and impermissible

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[11] With respect to the initial ergonomic interventions taken at the 9–1–1 center, Mr. James August of the American Federation of State, County and Municipal Employees testified: ''This intervention drastically reduced the injuries. It did not create more injuries * * *. [F]rom the entire work force of very high injury rates, virtually all of the carpal tunnel and wrist injuries were eliminated.'' (Tr. 17822)

With respect to the follow-up on the few new MSDs that developed, Mr. August stated:

> [T]here were a couple of employees where there were some shoulder problems that started to surface early on when the intervention was made * * *. But the same analysis that was done to identify the original problem was used to quickly remedy the resulting problem from the intervention.

> So it was not a matter of having to junk the whole system that was put in and start from scratch. This was a refinement which is what all of us involved in the field of ergonomics do on a continuous basis. [Tr. 17823]

enforcement strategy, contrary to applicable Constitutional and statutory requirements, leads to the unavoidable conclusion that the proposed standard is fatally defective and should be withdrawn. [Ex. 500–223]''

As noted in the discussion of the previous issue, OSHA has given employers sufficient guidance so that they can determine, before an inspection occurs, whether or not they are in compliance with the rule. In fact, if an employer reduces MSD hazards in accordance with or to levels below those in the hazard identification tools in Appendix D (or the more stringent Basic Screening Tool), there is no doubt that an employer is complying with the final rule's compliance endpoint. OSHA compliance staff will therefore have no difficulty determining whether an employer is complying with Appendix D. The remaining endpoints, controlling MSD hazards and feasibility, give added flexibility to those employers who believe that they can control MSD hazards by means other than the endpoints in Appendix D or who cannot feasibly reach those levels. Consequently, the final rule does not improperly delegate rulemaking authority to OSHA compliance staff.

3. Comments on Whether the Proposed Compliance Endpoint Would Force Employers To Go Too Far in Controlling MSD Hazards

a. *Comments that the proposed standard would force employers into a never-ending circle of hazard control improvements.* Some rulemaking participants were concerned that employers would face a never-ending circle of hazard control improvements (see, *e.g.,* Exs. 30–1722, 30–3956; Tr. 3171). For example, the National Coalition on Ergonomics stated that as long as ergonomic complaints [12] continued, employers would need to go further and further in the incremental abatement process (Ex. 30–3956). In addition, the Coalition asserted that, except where the employer can show the problem is unique to an individual employee, the employer would be obligated to implement corrective action not only for the complaining employee but for every employee doing the same job or another job involving the same or similar work activities. The Forum for a Responsible Ergonomics Standard went further, arguing that this portion of the standard was infeasible:

OSHA's proposal is infeasible, however, because it requires an undefined ''material reduction'' in MSDs, despite the fact that no technology, work practice, or other type of control exists that will ensure such reductions. Any mandatory standard must take into account the fact that numerous controls may be available and, perhaps, effective to some degree, but that they cannot ensure any rate of success in reducing MSD injuries or hazard factors. Employers simply will not be able to guarantee compliance with the standard, no matter what efforts they make to adhere to OSHA's proposed program. [Ex. 30–3845]

The American Iron and Steel Institute argued that the standard would necessitate more and more controls as employees deconditioned by an increasingly sedentary workplace would have less capacity to tolerate demanding physical activity (Ex. 30–3951, 32–206).

Under questioning at the hearing, Mr. Thomas Durbin of PPG Industries was concerned that an employer following the incremental abatement process would need to continue to apply control measures even after all workplace ergonomic stress factors were eliminated as long as MSDs continue to occur (Tr. 3171).

These comments are based on the false premise that an employer would not be finished applying ergonomic control measures until all MSDs disappear from the workplace. OSHA has drafted the final ergonomics standard to make it clear that this is not the case. The goal of the final rule is the reduction in workplace MSD hazards, that is the reduction in the frequency, magnitude, or duration of the risk factors causing MSDs in problem jobs. When an employer controls these risk factors to a level meeting one of the compliance endpoints given in paragraphs (k)(1)(i) through (k)(1)(iii), the employer does not have to institute further controls even if MSDs continue to occur. Consequently, OSHA has concluded that the final compliance endpoints will not force employers into a never-ending circle of hazard control improvements.

b. *Comments that the proposed standard forces employers to experiment with control measures until they find one that works.* Some rulemaking participants objected that the incremental abatement process would require employers to experiment with hazard control technologies of uncertain efficacy until the employer cannot afford to implement additional controls (see, *e.g.,* Exs. 30–296, 30–402, 30–1722, 30–2134, 30–4185; Tr. 4906, 5645). For example, the Chamber (Ex. 30–1722) argued that OSHA has left to employers what the Agency cannot do itself, that is, determine what controls will reduce significant risk to employees:

In sum, it is plain that the Agency is unable to make the difficult policy choices that Section 6(b)(5) places squarely in its hands, and that instead OSHA has chosen to defer these choices to the regulated community. The only justification that the Agency proffers for this flawed approach is that OSHA simply cannot determine broad standards that would be appropriate for the wide variety of covered industries and jobs. However, OSHA has fared no better in assessing causation and appropriate abatement when dealing with individual workplaces and specific jobs in enforcement proceedings. Thus, as noted above, OSHA has lost on one or both of those grounds in every ergonomics case it has litigated on the merits * * *. If, as these cases show, OSHA cannot determine what causes musculoskeletal complaints in a particular job-and how to abate them properly, there is no reason to think that employers will fare any better. [Ex. 30–1722]

The National Coalition on Ergonomics detailed this argument in their post-hearing submission (Ex. 500–197). The Coalition contended that ergonomics professionals are unable to articulate effective solutions to ergonomic problems in other than vague generalities, leaving employers little choice but to engage in trial and error experimentation. Because its review of the hearing transcript could not identify a single witness who was able to identify a particular ergonomic intervention that is sufficient to satisfy the rule, the Coalition questioned how well employers would be able to choose controls that would bring them into compliance.

In its post-hearing submission, Federal Express (FedEx) gave an example purporting to show how the company would be forced into experiments to try to reduce ergonomic risk factors further (Ex. 32–208). Federal Express noted that the existing workspace for package handlers is optimized so that a single employee reaches as short a distance as possible given the design of the conveyors, trucks, and other equipment. FedEx indicated that redesigning the space to accommodate a second employee would actually increase the distance packages are handled. The company argued that trading one risk factor for another, as such a redesign would cause, would have an unpredictable effect on the number of MSDs for that job.

On the other hand, Mr. Sittichoke Huckuntod, testifying on behalf of Levi Strauss and Company, acknowledged that industrial safety design is a system of trial and error by its very nature (Tr. 14747). The Forum for a Responsible Ergonomics Standard noted that addressing MSD hazards is an iterative process, often requiring significant trial

[12] As noted elsewhere in this preamble, the Coalition has mischaracterized the proposal's use of the term ''covered MSD'' as ''complaints.''

and error before improvements are realized (Ex. 30–3845).

OSHA acknowledges that fully solving ergonomics problems is not always straightforward. Some employers who have little or no expertise in ergonomics will indeed need to undergo some trial and error in their hazard control efforts. As noted by Ms. Sharon Murray, the former director of Rochester Office of Emergency Communications (a 9–1–1 call center), employees might not use new equipment intended to reduce risk factors in the manner anticipated by the employer (Tr. 17819). For example, when an employer institutes a control measure designed to reduce awkward wrist postures, it might increase long reaches for some employees. In Ms. Murray's case, the unanticipated hazard was a relatively simple problem to resolve (Tr. 17823).

The Agency does not believe that this trial and error is unique to ergonomic hazards. As Mr. Huckuntod acknowledged, industrial safety design is a system of trial and error by its very nature (Tr. 14747). A new ventilation system, for example, might not work as it is designed to, and the employer might have to modify it after its initial installation.

OSHA has removed the proposal's incremental abatement option and believes that employers will be able to meet the final rule's compliance endpoints with a minimum of experimentation. As the AFL–CIO (Ex. 500–218) noted, ''Several experts, including David Alexander (Tr. 2518, 2716), David Caple (Tr. 2716), and Dennis Mitchell (Tr. 2530), testified that in 80–85 percent of cases, ergonomic problems can be solved with one intervention.'' With the compliance assistance tools provided by the Agency, even small employers should be able to reduce MSD risk factors to acceptable levels with a minimum of experimentation. For these reasons, OSHA concludes that the final rule will not lead to undue experimentation by employers.

c. *Comments that the proposed standard places no limit on how far an employer must go in controlling MSD hazards.* Some rulemaking participants objected to any compliance endpoint that required an employer to eliminate MSD hazards from the workplace because such an endpoint places no limits on how far an employer must go in controlling MSD hazards (see, *e.g.,* Exs. 30–2208, 30–3765, 30–3956, 30–4185). For example, Dow Chemical Company noted that there is no such thing as zero risk and that this approach was inconsistent with OSHA's standards on toxic chemicals, which set exposure levels that entail some residual risk to employees (Ex. 30–3765). The National Coalition on Ergonomics also argued that the open-ended requirement to use all feasible control methods until the risk of an MSD reaches zero conflicts with well-established case law to the contrary (Ex. 30–3956). The Center for Office Technology also believed that OSHA is obligated to set a threshold above zero risk (Ex. 30–2208). Patrick Tyson of Constangy, Brooks and Smith asserted that the proposed rule, in essence, defined an MSD hazard as the existence of even one MSD in a 3-year period (Ex. 30–4185). Mr. Tyson contended that a rate of one OSHA recordable MSD every 3 years does not constitute a significant risk.

Some rulemaking participants were concerned that the standard placed no limits on the controls that an employer would be forced to implement (see, *e.g.,* Exs. 30–494, 30–2208, 30–3765, 32–211, 32–234; Tr. 10429, 10950). For example, Dow Chemical Company questioned the extent to which employers would need to go to avoid citations (Ex. 30–3765). Dow believed that the proposal would require employers to adopt the latest technology regardless of cost or how great the reduction in hazards. Mr. Gregory Watchman of Paul, Hastings, Janofsky and Walker stated that, if MSD signs and symptoms continue to occur, even on a sporadic basis, the employer would be forced to implement additional abatement measures indefinitely (Ex. 32–211). Mr. Watchman reasoned that the duty to implement additional controls would be triggered very frequently in most workplaces because of the frequency with which workers experience short-term discomfort, aches, and pains.

Mr. George Page, the owner of a small industrial engineering and ergonomics consulting firm, provided an example of why he thought the proposal's compliance endpoints went too far (Tr. 10429). He testified about a client who had instituted a variety of ergonomic initiatives with good results. Mr. Page was not sure whether the employer would be in compliance with the proposed rule.

The American Dental Association provided a theoretical example of how far the Association would have to go to control MSD hazards at their headquarters:

> The ADA headquarters is located in a building that was built more than 35 years ago. The work areas were designed and furnished before the proliferation of modem computing activities. It would not be cost-effective, or in some cases even possible, to retrofit them to satisfy the proposed standard. Thus, the ADA could be required to substantially rebuild or replace affected work areas, furnishings and equipment in order to comply. It is difficult at this point to determine the full scope of the ADA's compliance burden, because the proposed standard would require the ADA to continue to implement incremental changes to its work environment until it substantially reduced or eliminated the incidence of covered MSDs. Because 50% of the ADA's workforce is engaged in the same or similar work activities, the Association would be required to implement these changes for 200 employees simultaneously, even though only one employee reported a problem.
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> The ADA has made—and will continue to make—adjustments to keyboards, monitors and other peripheral aspects of its work environment, but for reasons of providing a more comfortable and efficient workplace for its employees, not because of some highly speculative benefit. However, there is no assurance that these simple measures would be sufficient to achieve compliance under the standard's incremental approach to compliance. [Ex. 32–141]

Federal Express argued that, because of the unique nature of its facilities, the company would see no appreciable effect from incremental changes to its workstations (Ex. 32–208). Federal Express further argued that only a complete redesign would accomplish anything more than negligible improvements in the number of workplace MSDs:

> While the proposed ergonomics standard provides for incremental changes to the work environment until ''covered MSD'' are significantly reduced, [footnote omitted] the unique nature of the facilities at and the corporate experience of FedEx is such that incremental changes would have no appreciable effect upon * * * reducing ''covered MSD,'' and only a quantum change involving complete redesign and reconstruction of facilities may potentially yield measurable results. Even then, it is not clear that the changes in outcome in which OSHA is interested is the result of these changes. The reason for the nebulous impact of incremental change is two-fold. First, the nature of the physical facilities which FedEx operates is such that space limitations do not allow further design alterations, added equipment, or additional, extraneous staffing. Second, FedEx's facilities, operational process and equipment have all been designed and employed with the application of ergonomic principles for the purpose of improving productivity. As a result, incremental changes to the workplace in the context of FedEx's facilities, which are already at or near the frontier of automation and technical feasibility will fail to have an appreciable impact upon the reduction rate of ''covered MSD.''
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> * * * * *
>
> To be sure, some incremental changes can be made. FedEx does not assert an ''all or nothing'' position, wherein absolutely no space whatsoever remains for incremental changes to be made in the existing facilities.

Rather, FedEx asserts that, to effect a material reduction in work-related ''covered MSD,'' the changes required would be quantum in nature, so as to necessitate an entirely new facility. The space limitation upon the existing facility will admit of some, very limited incremental changes, but those changes would be so limited by space, so ephemeral in nature, as to be ineffective in reducing ''covered MSD.''

For example, the design for the existing facilities, while tailored to the number of employees required to complete a task, is not precise to the person with regard to every position in the sort facility or even in the trucks or customer service stations. Rather, one additional person can, conceivably, be added to the workforce in some capacity in some facilities, in a manner where he or she will not detract from the efficiency of FedEx's operations. FedEx maintains, however, that the increase of one additional individual is not an administrative or work practice control which will render a material reduction of any hazard at all. In fact, the effect will not be noticeable, except on reduced efficiency. Once the workplace is increased significantly beyond one additional person, however, the facilities's space limitations operate to reduce both operational efficiency and workplace safety. [Ex. 32–208]

Patrick Tyson of Constangy, Brooks and Smith objected to the extent to which the proposed endpoint would require employers to go to reduce ergonomic hazards (Ex. 30–4185). He stated:

Having stated our objections, not to the need to implement engineering controls, but to the point at which such controls must be implemented, we also submit that contrary to OSHA's assertion in the Preamble that the proposed Standard establishes ''control endpoints'' which define when an employer is in compliance, there are two inter-related problems with § 1910.921. First, for any manufacturing jobs in which employees perform repetitive motion tasks for a significant part of the work day, as a practical matter, an employer's legal duty will never be satisfied until employees are no longer performing the manual tasks. We question whether the Agency should promulgate a Standard with this result, even if unintended. Secondly, although § 1910.921 is apparently intended to state that employers can be in compliance short of automating the job functions, we believe that there is no objective measure of compliance short of either automating the job task or function or eliminating it. [Ex. 30–4185]

He contrasted this with the expectation of OSHA enforcement staff that employers, under their existing general duty clause obligations, must institute controls that lead to a reduction in the seriousness of MSDs, not in their numbers. He also contrasted the standard's requirements with the experience of one of his firm's clients, who had instituted an ergonomics program and had 6-years' experience with it. This employer had spent over $19.5 million in capital improvements to reduce lifting hazards in six facilities and reduced the number of recordable MSD cases, including back cases, by less than 50 percent over the last 5 years of the program (through 1999). Mr. Tyson was particularly concerned that the standard would require this employer to institute further controls.

Here again, these comments are based on the false premise that an employer would not be finished applying ergonomic control measures until all MSDs disappear from the workplace. The final rule's compliance endpoints do not require employers to go that far in controlling MSD hazards. In fact, all the compliance endpoints in the final rule contain discrete stopping points that allow an employer to stop even if MSDs continue to occur. One of the endpoints, reducing MSD hazards in accordance with or to levels below those in the hazard identification tools in Appendix D, provides objective measures against which an employer can determine whether it has fulfilled its compliance obligations. When the employer reduces the risk factors below those levels, he or she is finished instituting control measures. The control of MSD hazards endpoint, although not as specific, also allows an employer to stop even if MSDs continue to occur. That endpoint, paragraph (k)(l)(i), requires reducing the hazard to the level where MSDs resulting in work restrictions or medical treatment are reasonably unlikely, not to the level of absolute safety or no MSDs. The endpoint will not require employers to seek to eliminate all aches and pains or symptoms of discomfort, as feared by Mr. Watchman. The required hazard reduction is directed at MSDs that require work restriction or medical treatment. The last endpoint is reducing MSD hazards to the extent feasible. When the employer has reached the limits of feasibility, he or she is in compliance regardless of whether MSDs are continuing to occur, at least until additional controls become feasible.

d. *Comments that requiring employers to go to the limits of feasibility is unreasonable.* Some rulemaking participants were concerned that the proposed requirement to control hazards to the extent feasible would require employers to continually review ergonomic research for the latest in control technology (see, *e.g.,* Exs. 30–2208, 30–2987, 30–4607, 32–234). For example, the Center for Office Technology argued that this requirement would be very costly as employers would be forced to replace office furniture every time a new desk is offered for sale. Concerned that employers would be forced to conduct constant reviews of new technology, the American Health Care Association recommended that OSHA provide technology and program upgrade information (Ex. 30–2987). The Association believed that the Agency was in a better position to determine when new and credible research made new control measures available. Caterpillar, Inc., stated that once ergonomic complaints cease there would be no need to review new technology (Ex. 30–4607). Caterpillar recommended that the standard not require the employer to assess additional controls unless a new MSD occurs.

Federal Express argued that, because an employee must handle every package at some point in the delivery process, complete elimination of human involvement cannot be achieved in its line of work (Ex. 32–208). In addition, Federal Express believes that it has reduced manual handling at its facilities as much as it can and, thus, is already at the limits of technological feasibility.

Keller and Heckman, L.L.P. believed that the proposed standard would require employers to research and develop technology to meet the proposal's compliance endpoint (Ex. 500–221). The law firm argued that the approach taken by the proposal was legally indistinguishable from the research and development requirement that the Third Circuit invalidated in *American Iron & Steel Institute* v. *OSHA,* 577 F.2d 825, 838 (3rd Cir. 1978). In that case, the Court held:

29 U.S.C. § 665(b)(5) grants authority to the Secretary to develop and promulgate standards dealing with toxic materials or harmful agents ''based upon research, demonstrations, experiments, and such other information as may be appropriate.'' Under the same statutory provision the Secretary is directed to consider the latest scientific data in the field. As we have construed the statute, the Secretary can impose a standard which requires an employer to implement technology ''looming on today's horizon,'' and is not limited to issuing a standard solely based upon technology that is fully developed today. Nevertheless, the statute does not permit the Secretary to place an affirmative duty on each employer to research and develop new technology. Moreover, the speculative nature of the research and development provisions renders any assessment of feasibility practically impossible. In holding that the Secretary lacks statutory authorization to promulgate the research and development provision, we note in passing that we need not reach petitioners' challenge to the provision as fatally vague. Accordingly, we hold the research and development provision of the standard to be invalid and unenforceable.

[*American Iron & Steel Institute* v. *OSHA,* 577 F.2d 825, 838 (3rd Cir. 1978) as quoted by Ex. 500–221]

Paul, Hastings, Janofsky, and Walker LLP stated that the preamble to the proposal indicated that the standard would be technology forcing:

The agency's impossibly burdensome definition of technological feasibility would make compliance * * * virtually impossible. OSHA asserts that a hazard control methodology is technologically feasible even if it is not currently available.

Thus, OSHA could issue citations and civil penalties to a small employer for failing to implement non-existent equipment that ''can be developed by improving existing technologies'' or that is ''on the horizon of technological development.'' 64 FR at 65823. [Ex. 30–3231]

The National Solid Wastes Management Association (Ex. 32–234) argued that OSHA's description of ''technological feasibility'' would make compliance with the proposed endpoint virtually impossible:

OSHA asserts that a hazard control methodology is technologically feasible even if it is not currently available. Thus, OSHA could issue citations and civil penalties to a small solid waste industry employer for failing to implement non-existent equipment that ''can be developed by improving existing technologies'' or that is ''on the horizon of technological development.'' 64 FR at 65823. [Ex. 32–234]

The American Transportation Association argued that OSHA could conclude that the employer had not gone far enough to control hazards even in the absence of continued MSDs (Ex. 30–4465). In support of this argument, the Association stated, ''if MSD symptoms persist, even on an occasional basis, an employer must continue to implement additional measures until it has exhausted all feasible controls.''

LPA, Inc., and others contrasted the types of controls OSHA has required when it cited employers for failing to abate ergonomic hazards under the general duty clause with the types of controls the Agency has stated that it will accept under the proposed rule (see, *e.g.,* Exs. 30–494, 32–208). LPA argued as follows:

Once a hazard is identified, an employer must implement ''feasible'' controls to try to eliminate it. A feasible control is one that is already being used elsewhere in the same job, can be adapted for the job, or ''is on the horizon of technological development.'' [Footnote omitted] OSHA insists that the available controls to fix hazards are usually neither complex nor costly. Although such controls may be accomplished through physical changes to the job, changes in work practices, or training in proper work techniques, [Footnote omitted] the standard expresses a preference for physically redesigning the job.

When citing ergonomics hazards under the general duty clause, however, OSHA has often required substantial physical changes, such as completely redesigning an assembly line and rebuilding the cab of a large crane. In many cases, these engineering controls favor automation and result in lost jobs. [Ex. 30–494]

The AFL–CIO noted that requiring employers to eliminate ergonomic hazards or implement controls to the extent feasible was similar to the approach OSHA uses in many other standards (Ex. 32–339). The union held that any incremental abatement process included in the final standard must have as its goal and endpoint the elimination of MSD hazards or the reduction of MSD hazards to the extent feasible.

The final rule contains an endpoint that would recognize that an employer is in compliance when he or she has done all that is feasible to reduce MSD hazards. This endpoint is statutorily driven. The OSH Act does not give the Agency the authority to require controls that are not capable of being done. This endpoint places a technological and financial limit on how far an employer must go in controlling MSD hazards.

As demonstrated by its feasibility analyses described in Chapter 3 of the Economic Analysis OSHA believes that most employers will be able to reach one of the other two endpoints (control MSD hazards or reduce MSD hazards in accordance with or to levels below those in the hazard identification tools in Appendix D) using existing technology at a cost that is economically feasible. The third endpoint, control MSD hazards to the extent feasible, is not technology-forcing in the sense feared by some commenters. As discussed earlier, what is feasible under the standard is determined by the limits of current technology and knowledge, not the potential for future technology.

Furthermore, OSHA believes that many of the comments on the corresponding compliance endpoint in the proposal were founded on the impression that the proposed rule would have required employers to eliminate MSDs from the workplace subject only to the limits of feasibility (see, *e.g.,* Exs. 30–3231, 30–3347, 30–3750, 30–4465, 32–211, 32–234). The language of the final rule's compliance endpoint makes it clear that this is not the case. The feasibility compliance endpoint in the final rule supplements the other two and ensures that no employer is required to go beyond the limits of feasibility.

OSHA has addressed the concerns of the American Health Care Association that employers would be forced to continually review new technology (Ex. 30–2987). Paragraph (k)(1)(iii) of the final rule requires employers to assess whether additional feasible controls are available every 3 years. This provision limits the frequency with which an employer would need to review technology, and the assessment could easily be done as part of the overall program evaluation. The Agency will be providing information on available control technology on its Web site and updating this information periodically. Employers should, however, check other sources of information to ensure that they have not overlooked new hazard controls that are appropriate for the MSD hazards in their workplaces.

The final compliance endpoint does not require employers to perform research and development to extend the limits of technological feasibility. As explained above, MSD control technology is feasible if the control method is available or adaptable to the employer's specific circumstances. Employers are not required to perform research on MSD control methodology or develop new technology to abate the MSD hazards in their workplaces.

e. *Comments that the proposed rule would force employers to automate jobs out of existence.* Some rulemaking participants argued that the ergonomics standard will lead to the elimination of jobs (see, *e.g.,* Exs. 30–1616, 30–3845, 30–3956, 30–4185; Tr. 5701). These commenters asserted that employers would act to reduce MSD hazards in the workplace by automating jobs out of existence, shifting jobs overseas, or converting full-time jobs to part-time to reduce exposure (see, *e.g.,* Exs. 30–3845, 30–3956). Several rulemaking participants were concerned about the feasibility of automating certain jobs (see, *e.g.,* Exs. 30–2208; Tr. 18033). For example, the Center for Office Technology stated:

To eliminate the hazard one must automate the work environment thus eliminating any exposure. Those are not OSHA's words but those are the examples OSHA gives (Fed. Reg. Page 65832). And in the case of the office, OSHA suggests that the only way an employer of office workers has eliminated the hazard is to use a voice-activated computer to eliminate highly repetitive motions. Here is where OSHA's definition of feasible falls apart for the office industry. Is it feasible to have voice recognition for computer input when for many applications, given the state of the technology, it is neither effective nor an adequate or available solution? Voice activation technology has come a long way, however, this technology is not at a point which it can be used for all applications. To use a technology that is still evolving and has limited effectiveness in some applications as an endpoint leaves employers in a never ending cycle with no true solutions. [Ex. 30–2208]

OSHA does not believe that this ergonomics standard will result in the elimination of a significant number of jobs through automation or in the conversion of full-time jobs to part-time. Employers use automation to promote efficiency and increase productivity, and reduction of MSD hazards is often a byproduct. The specific concern expressed by the Center for Office Technology is unfounded. OSHA referred to a voice—activated computer as an example of a control that would eliminate a repetitive motion hazard but did not mean to imply that all computer input would henceforth need to be done using voice-activation software. Appendix D makes clear that is not the case.

Automation for the sole purpose of reducing MSD hazards is typically unnecessary. Testimony by the United Auto Workers indicated that, in one of their programs covering about 4400 employees and involving over 1000 processes, only one problem job was fixed by automation (Tr. 14797). In addition, Mr. David Alexander (Tr. 2564), one of OSHA's expert witnesses with extensive experience in ergonomics, testified that most ergonomic solutions were low cost:

In my work, I found that about half of the projects cost less than $500 and can be done on a standard work order without the need for detailed justification. Perhaps that is why we do not hear about many of these low-cost solutions. Only a third of the projects need to cost more than $1,000. In other words, an ergonomics project is likely to cost, two times out of three, less than $1,000 and usually can fit within most budgets. [Tr. 2564]

These control methods do not approach the cost of automation. Consequently, simple economics will keep most employers from automating jobs simply to control ergonomic hazards. Mr. Alexander also stated that for a single set of risk factors as many as five to ten different solutions can be developed and employers should not be forced to convert full-time jobs to part-time. If reduction of exposure time is a control an employer selects, rotating employees among different jobs would normally be a cost-effective alternative to the use of part-time workers to replace full-time employees.

4. Comments on Whether the Proposed Compliance Endpoint of Eliminating MSD Hazards Is Illusory Because MSDs Cannot Be Eliminated

Some rulemaking participants criticized the final means of compliance, ''eliminating MSD hazards'' (see, *e.g.*, Exs. 30–323, 30–1107, 30–1722, 30–3845; Tr. 8328). For example, the US Chamber of Commerce stated that activities that the Agency characterizes as MSD hazards are ''universal activities of life, both in and out of the workplace, that can never be completely eliminated.'' The Chamber also noted that certain risk factors may pose MSD hazards to some employees but not to others due to their unique susceptibilities and prior medical history. Thus, the Chamber concluded, ''Without knowing how an innumerable list of confounding factors might coalesce to cause an MSD in a given individual, neither OSHA nor an employer can ever say whether a significant risk of harm exists and, short of eliminating the job altogether, it will be impossible to say when all possible ergonomic ''risks'' have been eliminated. [Ex. 30–1722]'' Other rulemaking participants made similar arguments (see, *e.g.,* Exs. 30–297, 30–323, 30–2208, 30–3765, 30–3845, 30–3934, 30–4185; Tr. 2960, 5342). These commenters said that nonwork-related factors also cause MSDs and that some MSDs will continue to occur even after employers control all work-related hazards. For example, the Forum for a Responsible Ergonomics Standard stated that employers cannot control the predisposition of their employees to contract MSDs (Ex. 30–3845). The Forum asserted that women are susceptible to carpal tunnel syndrome for a variety of reasons, including because they have smaller wrists and greater fluid retention. Similarly, Metz Baking Company stated: ''* * * OSHA's proposal essentially forces companies into the pursuit of continuous efforts to reconfigure their workplaces and methods of operation down to a level that is without physical stressors for the most vulnerable of its employees [Ex. 30–323].'' Some rulemaking participants noted that the standard did not hold employees accountable for their own behavior on and off the job (see, *e.g.,* Exs. 30–3355, 30–3723; Tr. 8328). For example, Mr. Perry Ozburn, the chairman of the International Warehouse Logistics Association, recounted a case in which his company had to pay benefits to an employee who Mr. Ozburn believed was injured off the job (Tr. 8328).

Mike Redman of the National Soft Drink Association argued the fact that employees in certain jobs will experience MSDs despite the best efforts of their employers (Tr. 2960). He reasoned that, because the probability of an MSD occurring in such jobs is always 100 percent, the employer will not be able to materially reduce the likelihood that an injury will occur.

Once again, the premise of these comments is that the proposed standard would have required employers to eliminate MSDs from the workplace. As noted earlier, the final rule's compliance endpoints stop short of this and provide clearly defined goals. OSHA realizes that employers cannot prevent all MSDs. In addition, the final rule, like the proposal before it, includes a note that the occurrence of an MSD is not, in and of itself, a violation of the hazard control endpoint.

5. Comments on Whether Some MSD Hazards Are Beyond the Employer's Control

Some rulemaking participants, particularly those representing the ambulance service, solid waste, and moving and storage industries, were concerned that employees were exposed to ergonomic hazards that were out of the employer's control (see, *e.g.,* Ex. 30–3686, 30–3845; Tr. 8140, 14957, 18030). For example, Mr. Ron Thackery, representing the American Ambulance Association, testified that not only were the lifting hazards faced by ambulance crews beyond the control of employers but that there were no feasible control measures that his industry could use to meet the compliance endpoint required by the proposed standard (Tr. 15017).

The final rule's compliance endpoint recognizes that some aspects of an employer's hazard control efforts may be limited by the availability of feasible controls. To the extent that the MSD hazards an employee faces are completely out of the employer's control, the final rule does not require the employer to control them. (For an analysis of the comments on the feasibility of controls in various jobs, see the discussion of technological feasibility in the Economic Analysis section later in the preamble.) For example, for paramedics responding to an automobile accident, the employer would have no control over the weight of the accident victims or their positions at the accident scene. These factors are highly variable and cannot be controlled by the employer. However, there are certain administrative and engineering controls that are available and, to the extent they can be used, the employer is required to implement them. For example, work rules (with associated training) can assure that employees minimize the risk involved in moving accident victims.

When work rules are used as an administrative control of MSD hazards, the employer is obligated to institute an adequate work rule, train employees in it, take steps to find violations, and enforce the rule uniformly. If the employer has done those things and an employee violates that rule without the employer's knowledge, then the employer will not be cited for that violation (see section III.C.8.c(1) of OSHA's Field Inspection Reference Manual, CPL 2.103.). The courts and OSHA Review Commission do recognize a defense of unpreventable employee misconduct. See, *e.g., D.A. Collins Constr. Co.* v. *Secretary of Labor,* 117 F.3d 691 (2nd Cir. 1997). Thus, the fears expressed by Guilford Mills (Ex. 30–2990) and the Oregon Dental Association (Ex. 32–233) that employers would be held responsible for unpreventable violations of work rules by their employees is unfounded.

7. Whether the Proposed Incremental Abatement Process Endpoint is Appropriate

The proposed incremental abatement process (§ 1910.922) would have allowed employers to test solutions in a problem job, so long as they would result in some hazard reduction and wait and see whether an additional MSD occurred before trying out further controls.

This proposed provision drew substantial comment on both sides. Many commenters objected to it as written because they believed it would permit employers to delay implementing controls that were needed to protect workers. The AFL–CIO recommended changing the provision to avoid this problem.

The AFL–CIO believes that any incremental abatement process included in the final standard must have as its goal and endpoint the elimination of MSD hazards or the reduction of MSD hazards to the extent feasible. Employers can eliminate or reduce these hazards incrementally, focusing first on the high duration, high frequency and high intensity risk factors identified in the job analysis. Employee reports of MSDs or symptoms can and should be used to help set priorities for action and to help determine which jobs need further attention, but they should not be the endpoint for when and whether an employer has instituted sufficient controls.

The final standard must also set a compliance deadline for implementing all feasible controls through the incremental abatement process. OSHA should make clear that the same compliance deadlines for permanent controls (*i.e.,* within three years during the startup period and within one year thereafter) apply, regardless of the abatement process an employer chooses to utilize. [Ex. 32–339]

The International Brotherhood of Teamsters stated that the incremental abatement of hazards would be acceptable within a framework of continuous ergonomic improvement that incorporated symptom surveillance, reaction to ergonomic complaints, active risk factor analysis, and continuing training (Ex. 500–207). The IBT also believed, however, that the final ergonomics standard must specify time frames and deadlines for the incremental abatement process.

Other rulemaking participants were also concerned about the lack of a time limit between incremental control steps (see, *e.g.,* Exs. 32–111, 32–210). The United Steelworkers of America suggested that OSHA provide additional guidance to assist employers in determining how long they may wait for an injured employee's condition to improve before implementing additional control measures (Ex. 32–111). The United Food and Commercial Workers International Union also recommended that the incremental abatement process have the same endpoint as the other two compliance options (Ex. 32–210).

On the other hand, the Integrated Waste Services Association urged the Agency to allow for flexibility in this regard, stating:

The timing of the incremental abatement process will require it to be very specific to the situation. Consequently, standardized measures of timeliness would be ineffective and impractical. The employer should be permitted to gauge its own unique time frame for each and every WMSD. [Ex. 32–337]

In its post-hearing submission (Ex. 500–218), the AFL–CIO criticized the provision as allowing an employer to implement minimal controls for a problem job until a new injury occurs. According to the AFL–CIO, ''[r]equiring employers only to 'significantly reduce the likelihood that covered MSDs will occur,' and then allowing them to avoid further intervention until another injury occurs is an unacceptable, unprotective compliance endpoint that is totally at odds with the language and purpose of the Act.'' The United Auto Workers expressed similar concerns. ''The plain meaning of 'incremental abatement' is that all feasible controls will not be implemented in the first instance. Instead, the employer is permitted to implement some but not all feasible controls, and then wait for a second employee to be injured before going the rest of the way.'' (Ex. 32–185).

Other rulemaking participants supported the proposed incremental abatement process (see, *e.g.,* Exs. 30–434, 32–450; Tr. 14854). For example, Ms. Barbara Fritz testified that she used an incremental process of applying a control measure and seeing if it works in her efforts to abate ergonomic hazards (Tr. 14854). Monsanto Company stated:

We agree that using an ''incremental abatement process'' is a valid method of dealing with physical stresses. In some instances you implement a potential solution to a problem and find that once in place additional improvements are either necessary or possible. It is also possible that from a budgeting standpoint you may not be able to implement the full-scale solution until you can obtain the necessary capital, so you implement partial solutions until capital is available. [Ex. 30–434]

NIOSH (Ex. 32–450) also supported the incremental abatement process in the proposed standard:

We agree that control of MSD hazards can be appropriately achieved through the use of the incremental hazard abatement process proposed in Section 1910.922, allowing employers to implement controls in increments in order to understand which solutions work among all potentially necessary controls, and to implement only those controls that are necessary. We believe that it is essential and standard practice in many existing ergonomic programs for the routine reassessment of jobs in which initial control measures fail to reduce the severity or occurrence of MSDs. This reassessment should trigger implementation of additional feasible control measures. This process also allows employers to select the best solutions to eliminate or materially reduce the MSD hazard most efficiently, and to periodically check for new controls capable of further material reduction of the hazard. [Ex. 32–450]

Having considered the views expressed by the commenters, OSHA concludes that it is not necessary to include a separate provision in the standard on incremental abatement as the time frames for implementing controls allow employers to follow an incremental abatement process without a separate provision to that effect. The proposed incremental abatement provision recognized that the most cost-effective approach to reducing or eliminating MSD hazards is at times an incremental one. Employers may try some basic, inexpensive controls and see how well they work in reducing hazardous exposures before determining whether additional controls are needed. The proposed incremental abatement process was intended to make clear that employers are permitted to follow such an approach. OSHA has concluded, however, that it is not necessary to include a separate provision about incremental abatement in the standard. The standard allows employers up to 2 years (4 years initially) to control problem jobs, and these time frames are sufficiently long to enable those employers who wish to do so to follow an incremental abatement approach. A separate provision on incremental abatement would therefore be redundant.

Elimination of the incremental abatement provision also accommodates the concern expressed by the AFL–CIO and UAW that the provision allowed employers to implement minimal controls and wait until additional MSDs occur before completing abatement. Under the final standard, once an employer has identified a problem job, it must now attain one of the compliance endpoints for all employees in that job within the time frame set out by the standard. Thus, while the final standard allows incremental abatement within its time frames, once a problem job has been identified that the employer must control, the employer's abatement obligation does not depend on the occurrence of additional MSDs.

7. Whether the Final Ergonomics Standard Should Allow Employers to Prioritize the Control of MSD Hazards

Some rulemaking participants were concerned that the proposed compliance endpoints limited the ability to prioritize the control of MSD hazards (see, *e.g.,* Ex. 30–3813; Tr. 3135, 14722). For example, PPG Industries believed that the incremental abatement process outlined in the proposal limited the employer's ability to prioritize hazards (Tr. 3135).

Sean Cady, representing Levi Straus and Company, testified that the proposal did not provide sufficient guidance for the employer to prioritize jobs for the analysis and control of hazards:

Well I would say first that we're here today to talk about our ergonomic program and what we've learned over the last 10 years of having a formal program in place. But one of the concerns that comes to mind is the proposal doesn't seem to provide enough guidance on how an employer should prioritize jobs for things like hazard analysis and job modification and control if more than one job is triggered at the same time. [Tr. 14722]

The United Auto Workers believed that it is important to prioritize jobs and hazards for control (Ex. 32–185; Tr. 8102–8104). The UAW suggested that the employer could use tools such as the NIOSH Lifting Equation, Snook and Ciriello Push-Pull tables, and various checklists, to identify which job elements and risk factors are most important (Ex. 32–185). The union recommended that employers be required to abate all risk factors classified as high priority but be allowed to abate other MSD hazards at a later time. The UAW argued that this was the proper way for employers to materially reduce risk factors under the incremental abatement process.

In its post-hearing submission, the AFL–CIO recognized that some employers may have difficulty in meeting the proposed rule's compliance endpoints by the deadlines contained in the proposal (Ex. 200–218). To remedy this problem, the AFL–CIO suggested that the final ergonomics standard allow employers an additional year to meet the compliance endpoint if the employer:

(1) Has conducted the job hazard analysis required by the standard,

(2) Has identified MSD hazards,

(3) Has consulted with employees and their designated representatives, and

(4) Has developed an action plan for eliminating MSD hazards.

According to the union, the action plan should prioritize the control of MSD hazards and provide for measurable reductions in exposure to those hazards, and the employer should be required to implement controls in accordance with the action plan and evaluate whether the controls have reduced exposures.

The AFL–CIO reasoned that its recommendation, which was consistent with other OSHA standards, would provide employers with sufficient time to eliminate MSD hazards without unnecessarily exposing employees to injury:

The concept of an action plan or compliance program to set forth the process and means by which an employer will achieve compliance is an established practice under OSHA standards. The majority of OSHA's health standards, including standards on lead (1910.1025), cadmium (1910.1027), arsenic (1910.1018), and methylene dianaline (MDA) (1910.1050) contain a requirement for the establishment and implementation of a written compliance program.

Similarly, a number of OSHA standards have recognized that in some industries or some establishments it may not be possible to achieve the control endpoint by the compliance date established for other industries and employers. In these cases, OSHA has on occasion included provisions to extend the compliance date for the implementation of controls.

Under the arsenic standard, employers who were unable to achieve compliance with the PEL through engineering controls and work practices by the compliance date of December 1, 1979, were required to include in their compliance plan an analysis of the effectiveness of controls, and were required to install engineering controls, and institute work practice controls on the quickest schedule feasible [1910.1018(g)(2)(ii)(F)].

The AFL–CIO believes that the provision of a one year extension in the abatement date accompanied by the development and implementation of an action plan is an appropriate means to address more complex hazards and is consistent with the practice under other standards. We recommend that such a provision be included in the final standard. [Ex. 500–218]

OSHA acknowledges that some employers will have difficulty controlling MSD hazards in all problem jobs within the deadlines that would have been imposed by the proposed standard—permanent controls would have had to be in place within 3 years after the effective date initially and, if the initial compliance deadline has passed before an MSD occurs, within 1 year of the incident. To alleviate this problem, the final ergonomics standard gives employers an additional year to implement permanent controls—permanent controls must be in place within 4 years after the effective date initially and, if the initial compliance deadline has passed before an MSD occurs, within 2 years after the employer determines that the job meets the Action Trigger. (These deadlines and the reasoning behind them are explained in more detail in the summary and explanation for paragraph (x), later in this section of the preamble.)

OSHA is not, however, providing a prioritization requirement in the final rule. With the extended deadlines for the implementation of permanent controls, employers will have sufficient time to install all controls necessary to meet the final rule's compliance endpoint.

Employers are free to prioritize the installation of permanent controls within the compliance deadline for MSD problem jobs. There are many ways of assigning priorities to jobs. Priorities can be assigned on the basis of risk, severity, cost, or other reasons. As long as all required permanent controls are in place by the compliance deadline, the Agency does not believe it is necessary or appropriate for the standard to specify a prioritization schedule. Consequently, the final rule contains no requirements on prioritization.

Paragraph (l)—What Kinds of Controls Must I Use to Reduce MSD Hazards?

Paragraph (l) of the final rule requires the employer to use feasible engineering, work practice, or administrative controls, or any combination of them, to reduce MSD hazards in problem jobs. The standard also allows employers to use personal protective equipment (PPE) to supplement these controls but stipulates that PPE may not be used alone unless other controls are not feasible. In addition, the standard requires any PPE that is provided to be furnished to employees at no cost.

This paragraph of the standard is almost identical to the parallel proposed provision, with one exception. A footnote to this paragraph in the proposal would have prohibited the use of back belts/braces and wrist braces/splints as PPE; this footnote has been deleted from this paragraph of the final rule. As explained below, OSHA believes that evidence in the record suggests that back belts, in some limited applications, may help to reduce MSD hazards. However, back belts, like other PPE, may not be used alone if other controls are feasible. Wrist splints, wrist braces, and back braces, which are post-injury devices used to speed rehabilitation, are not considered PPE for the purposes of this standard.

Paragraph (l)(i)—Feasible Controls

Paragraph (l)(i) of the final standard mandates the use of feasible controls (engineering, work practice, and administrative controls) or any combination of them to control or reduce MSD hazards in problems jobs. This paragraph also states that engineering controls, where feasible, are the preferred method of control. This paragraph of the final rule is essentially unchanged from the proposal. OSHA is allowing employers this flexibility in the choice of controls because the Agency's experience and information in the rulemaking record indicates that these control approaches have been effective in contributing to reductions in the number and severity of workplace MSDs. In addition, OSHA believes that the broad range of jobs to which the standard will apply, and the great variation in workplace conditions covered, make compliance flexibility essential.

The final standard defines engineering controls as controls that physically change the job in a way that controls or reduces MSD hazards. Examples of engineering controls that are used to address ergonomic hazards are workstation modifications, changes to the tools or equipment used to do the job, facility redesigns, altering production processes, and/or changing or modifying the materials used. Engineering controls range from very simple to complex: from putting blocks under a desk to raise the work surface for a taller-than-average worker to providing a lumbar support pillow or rolled-up towel to a video display unit (VDU) operator, to redesigning an entire facility to enhance productivity, reduce product defects, and reduce workplace MSDs.

When choosing an engineering control to address a particular ergonomic problem, employers often have many choices, depending on how much they wish to spend, how permanent a solution they seek, how extensive a production process change they need, and employee acceptance and preference (see the discussion of control approaches in the summary and explanation for paragraph (m)). For example, as MacLeod (Ex. 26–1425) points out, an employer whose VDU operators are experiencing neck and shoulder problems has many options available, including the following:

- Raising the height of the monitor by putting it on phone books, building a monitor stand, buying an adjustable monitor stand, buying an adjustable wall-mounted monitor stand, or buying an adjustable desk-mounted monitor stand;
- Putting the desk on blocks; or
- Providing an adjustable-height desk or workstation.

Work practice controls involve changes in the way an employee does the job. They are defined by the standard as changes in the way an employee performs the physical work activities of a job that reduce exposure to MSD hazards. Work practice controls involve procedures and methods for safe work. Examples of work practices that reduce the potential for exposure to ergonomic risk factors are the use of neutral positions or postures to perform tasks (keeping wrists straight, lifting close to the body), use of two-person lifts when mechanical lifts are not available, and the observance of micro-breaks as necessary to minimize muscle fatigue. In the context of ergonomic programs, work practice controls are essential, both because they reduce ergonomic stressors in their own right and because they are critical if engineering controls are to work effectively. For example, workers need to be trained to use a power grip rather than a trigger grip if a new tool is to be successful, and they need to know how to adjust an ergonomically designed chair properly if it is to substantially reduce the risk of neck disorders, shoulder tendinitis, or another type of MSD. Work practices, like learning to vary job activities during the day (*e.g.,* moving from filing to sorting mail to using the computer and back again) can often reduce the magnitude and duration of exposure to the relevant risk factor sufficiently to make MSDs unlikely. To be effective, the culture at the workplace and supervisory support and reinforcement are necessary to ensure that safe work practices are routinely observed.

Administrative controls are work practices and policies implemented by the employer that are designed to reduce the magnitude, duration, and/or frequency of employee exposure to risk factors by changing the way work is assigned or scheduled. Examples of administrative controls that are used in the ergonomics context are employee rotation, job enlargement, and employer-initiated changes in the pace of work.

Administrative controls have been effective in addressing MSD hazards in a number of cases. For example, one case study cited in the Benefits chapter (Chapter IV of the Final Economic Analysis) describes a lift team approach that has been effective in reducing work-related back injuries among nursing personnel in a long-term care facility for the elderly (Ex. 26–1091). The table of ergonomic program and intervention case studies in Section VI shows dozens of examples of the successful use of administrative controls, either alone or in combination with other controls.

However, administrative controls must be used carefully if they are to provide effective protection to employees. A well-known ergonomics book, MacLeod's ''The Ergonomic Edge,'' cautions:

> * * * job rotation is only beneficial if the tasks involve different muscle-tendon groups or if the workers are rotated to a rest cycle * * *. Furthermore, job rotation alone does not change the risk factors present in a facility. Although job rotation may have beneficial effects, engineering changes should remain the goal of the ergonomics program (Ex. 26–1425).

OSHA agrees, and paragraph (l)(1) notes, that engineering controls are the preferred method of controlling MSD hazards in cases where these controls are feasible. In contrast to administrative and work practice controls or personal protective equipment (PPE), which traditionally have occupied lower tiers of the hierarchy, engineering controls fix the problem once and for all.

Many commenters agreed that engineering controls are generally superior to other controls, *i.e.,* administrative controls, work practices, or personal protective equipment (see, *e.g.,* Exs. 26–1487, 26–1428, 26–1424, 26–2; 26–1426, 26–1425, 26–1408; and 26–3). For example, a recent ergonomics text states:

> Ergonomic hazards can be effectively eliminated by introducing engineering

controls and applying ergonomic principles when developing workstations, tools, or jobs * * * only engineering controls eliminate the workplace hazards. Other strategies [work practices, administrative controls] only minimize the risk of injury (Ex. 26–1408).

However, a number of commenters mistakenly understood OSHA's statement in the proposal about the preferred status of engineering controls. These commenters understood this statement to mean that administrative or work practice controls could not be used in lieu of engineering controls. This was not OSHA's intent, nor is the inclusion of this statement in the final rule to be interpreted that way. In the final rule, as in the proposal, OSHA is permitting any combination of controls (except PPE) to be used to control MSDs, either alone or in combination. OSHA agrees, as these parties (see, *e.g.,* Exs. 30–3344, 30–4628) argued, that in many cases, the use of administrative or work practice controls alone may eliminate the hazard and thus obviate the need for more expensive engineering controls. For example, the Milliken Company stated:

The authorization in [proposed] section 1910.920(a) for employers to use any combination of engineering, administrative, and work practice controls is effectively rendered meaningless with the statement that follows, which specifies that engineering controls are the preferred method for eliminating or materially reducing MSD hazards. This provides too much latitude for OSHA area directors to issue citations when an employer has used administrative and work practice controls rather than engineering controls (Ex. 30–3344).

Other commenters who misinterpreted the proposed statement about the preference for engineering controls were concerned that this preference could greatly increase the costs of compliance if OSHA enforced this provision. For example, the Rubber Manufacturers Association emphasized that ''* * * the hierarchy placing engineering controls over other alternatives * * * restricts employers' discretion to choose less expensive, non-engineered alternatives'' (Ex. 500–95). Other groups, such as Pharmteck (Ex. 30–4122) and Southern States Cooperative Inc. (Ex. 30–394), argued that ''* * * a vast percentage of workplace injuries result not from exposure that might be limited through engineering solutions, but from problematic employee behavior and safety related decisions.'' Issues of feasibility were pointed to by several commenters (see, *e.g.,* Exs. 30–3368, 30–4264) such as the National Soft Drink Association, which stated:

Although the employer is allowed to use any combination of controls, OSHA makes clear that engineering controls are preferred, where feasible. Lacking any definition or guidance of the term ''feasible'' complicates understanding or complying with OSHA's intent in this regard. Such ambiguity will undoubtedly lead to disagreements between employers and OSHA compliance personnel (Ex. 30–3368).

In response, OSHA notes that the hierarchy of controls has been an established industrial hygiene practice since the 1950s and has been a longstanding OSHA policy, as evidenced by many of the Agency's standards (*e.g.,* asbestos, § 1910.1001; benzene, § 1910.1047; cadmium, § 1910.1027; and methylene chloride, § 1910.1052). As was stated in the proposal, ergonomists endorse the hierarchy of controls because they believe that control technologies should be selected based on their reliability and efficacy in controlling or reducing the workplace hazard (exposure to risk factors) giving rise to the MSD. OSHA does not agree that ''problematic employee behavior'' is the cause of occupational injuries and illnesses, nor that feasibility will be a concern with this standard, in large part because the standard allows such flexibility in control approach and requires only that employers implement feasible controls.

Many groups (see, *e.g.,* Exs. 32–21–1–2–19, 20–69, 20–22, 30–4538, 30–3683) commenting on the proposal strongly supported the hierarchy of controls. For example, the American Association of Safety Engineers stated:

We agree that engineering controls should be the first option in alleviating WMSDs. While this type of approach could be the most expensive from the short-term perspective, our experience is that engineering controls are the most efficient/effective approach in the long-term (Ex. 32–21–1–2–19).

OSHA agrees that the use of engineering controls is the most effective way of controlling the MSD hazards. However, as discussed above, this standard permits employers to use any combination of controls, except PPE alone, to address MSD hazards in their workplace.

Paragraph (l)(2)—Personal Protective Equipment

Paragraph (l)(2) of the final standard permits employers to use personal protective equipment (PPE) to supplement engineering, work practice, and administrative controls. However, personal protective equipment may not be used alone, *i.e.,* as the sole means of employee protection, unless no other controls are feasible. In addition, any PPE that is provided must be made available to employees at no cost.

PPE is equipment that is worn by the employee and reduces exposure to risk factors and MSD hazards in the job. Examples are palm pads and knee pads to reduce contact stress, vibration-attenuation gloves, and gloves worn to protect against cold temperatures.

The hierarchy of controls, which, as discussed above, is widely endorsed by ergonomists, occupational safety and health specialists, and health care professionals, accords last place to PPE because:

- Its efficacy in practice depends on human behavior (the manager's, supervisor's and worker's),
- Studies have shown that the effectiveness of PPE is highly variable and inconsistent from one worker to the next,
- The protection provided cannot be measured reliably,
- PPE must be maintained and replaced frequently to maintain its effectiveness,
- It is burdensome for employees to wear, because it decreases mobility and is often uncomfortable,
- It may pose hazards of its own (*e.g.,* the use of vibration-reduction gloves may also force workers to increase their grip strength).

One author (Ex. 26–1408) notes that: ''* * * in most cases, the use of PPE focuses attention upon worker responses and not the causes of ergonomic hazards.* * * PPE does not eliminate ergonomic hazards * * * [and] must be considered as the last line of defense against ergonomic hazard exposure.'' Thus, although the final standard permits PPE to be used as a supplemental control, it cannot be relied on as a permanent solution to MSD hazards unless other feasible controls are unavailable.

In the proposal, OSHA included a note to the proposed section on the hierarchy of controls that stated that back belts/braces and wrist braces/splints were not to be considered PPE for purposes of the standard. This note was added to alert employers to the fact that back belts and wrist braces, which are widely used in U.S. workplaces, were not to be considered a control to reduce ergonomic hazards under the proposed standard. OSHA pointed out that these devices were being marketed as equipment that could prevent MSDs, although the evidence to support these claims was inconclusive.

A number of commenters and studies in the record (see, *e.g.,* 32–30–1–15, 32–30–1–6, 32–30–1–7, 32–30–1–29, 32–30–1–14) suggest that OSHA should allow the use of back belts as PPE on the grounds that these devices have been shown to reduce workplace injuries. For example, Mr. Jeffrey Whitaker commented that:

> As safety professionals we realize that back supports alone are not a solution and we apply the hierarchy of controls in our work with our customers on a daily basis. We recommend engineering and work practice controls be used whenever possible but we all know of hundreds of workers' whose jobs will never or cannot be changed. These workers need at least a modicum of support when doing their jobs. Back supports are used in these situations to provide a basic line of defense for vulnerable workers (Ex. 30–2724).

Commenters from Chase Ergonomics were of the same opinion:

> Back supports should be recognized as an acceptable component of an overall back safety program under the hierarchy of controls. As with any PPE, back supports are not the first intervention option. In many jobs, however, neither engineering controls nor work practice or administrative controls are feasible or practicable. In these circumstances, OSHA's PPE standard allows employers to provide workers with protective equipment that is appropriate for the hazards present * * * OSHA should clarify that employers may use back supports as a supplement to their overall back injury prevention program (Ex. 30–3857).

However, other organizations and commenters cautioned against the use of back belts as PPE. For example, in a 1994 report reviewing the available scientific literature on the use of back belts, NIOSH expressed concern that wearing a belt may alter workers' perceptions of their capacity to lift heavy workloads (*i.e.,* belt wearing may foster an increased sense of security, which may not be warranted or substantiated) (Ex. 15–16). NIOSH does not recommend the use of back belts as PPE, and neither do a number of professional societies (Exs. 15–15, 15–17, 15–33, and 500–41–99).

However, in response to comments submitted to the record regarding back belts, OSHA has reviewed the available scientific literature addressing the efficacy of back belts in reducing MSDs. OSHA has conducted an extensive review of the evidence in the record on the effectiveness of back belts in industrial use. The evidence is mixed. Several studies (see, *e.g.,* Exs. 32–30–1–21, 32–30–1–22, 32–30–1–2, 32–30–1–8, 33–30–1–16, 32–31–1–23) of back belt use showed negative results. For example, a 1996 study by Rafacz and McGill (Ex. 32–30–1–21) that investigated the effectiveness of back belts in 20 healthy male subjects found that belt wearing increased diastolic blood pressure during every task performed by the study subjects. The authors concluded that ''wearing an abdominal belt may put undue strain on the cardiovascular system and * * * that screening for cardiovascular compromise should be conducted before occupational belt-wearing.'' Another study (Alexander *et al.* 1995) that evaluated belt use in nursing, dietary, and environmental services workers found no significant differences in the number of self-reported back injuries. The authors concluded that ''This finding supports research [showing] that universal prescription of back belts did not decrease the number of back injuries and that there [is] no support for uninjured workers wearing back belts to reduce risk of injury.'' (Ex. 32–30–1–2).

A number of back belt studies in the literature report inconclusive results (see, *e.g.,* Exs. 32–30–1–22, 32–30–1–8, 32–30–1–24, 32–30–1–12). For example, a study by Kraus *et al.*1996 (Ex. 32–30–1–12) reported a lower acute back injury rate among belt users than non-users, but cautioned that a number of confounders, such as the inability to evaluate injury status, job lifting intensity, or length of employment ''may be important confounders or effect modifiers that delimit the potential effect of back supports.''

However, a number of recent studies (see, *e.g.,* Exs. 32–30–1–25, 32–30–1–6, 32–30–1–7, 32–30–1–14, 32–30–1–19) contain limited evidence that back belt use can, in certain circumstances, provide some protection to workers. For example, a 1998 study evaluated trunk stiffening during flexion and lateral bending and concluded that ''increased spine stability may provide greater protection against injury following unexpected or sudden loading'' (Ex. 32–30–1–6). A 1995 review of the literature on back belt effectiveness (Ex. 32–30–1–7) concluded: ''Based on our assessment of the * * * studies reviewed in this paper, a major finding is that back supports designed solely for specific purposes could be biomechanically, physiologically, and psychophysically effective in relieving the loads on the lumbar spine for employees engaged in many industrial operations.'' A study by one of OSHA's expert witnesses, Dr. Stephen Lavender (Ex. 32–30–1–14) that evaluated the effect of lifting belts, foot movement, and lift asymmetry on trunk motions, concluded that the lateral bending and twisting motions of the torso are controlled with belt use.

OSHA's review of the voluminous record on the back belt issue shows that back belts may have protective effects in certain industrial settings, such as sudden unexpected loading of the spine (Ex. 32–30–1–14). OSHA is aware that several of these studies had small sample sizes (*e.g.,* 10 subjects) (Ex. 32–30–1–6), lacked control groups, and were of short duration. Nevertheless, the Agency is persuaded that the evidence for the effectiveness of back belts, although limited, exceeds that available for other types of equipment that workers wear that is classified as PPE (*e.g.,* palms pads, knee pads). OSHA has therefore decided not to prohibit the classification of back belts as PPE for the purposes of this standard. Accordingly, the note to that effect contained in the proposal does not appear in the final rule. Permitting back belts to be used as PPE means that employers will be required to provide them to their workers, if they choose to do so, at no cost to employees. Further, as with any PPE, back belts used in this manner are subject to OSHA's standard for PPE (29 CFR 1910.132).

OSHA does not believe that the record in this rulemaking does not support permitting other devices, such as back braces and wrist braces or splints, which are generally prescribed as part of a treatment regimen, to be considered PPE. These devices are generally prescribed for individuals who have already been injured, and are not intended to be used in the prevention of injuries. In some cases, they may even exacerbate an existing MSD hazard. As explained by the AIHA, wrist splints and braces may present serious problems:

> Wrist splints or braces used to keep the wrist straight during work are not recommended, unless prescribed by a physician for rehabilitation. * * * using a splint to achieve the same end may cause more harm than good since the work orientation may require workers to bend their wrists. If workers are wearing wrist splints, they may have to use more force to work against the brace. This is not only inefficient, it may actually increase the pressure in the carpal tunnel area, causing more damage to the hand and wrist.'' (Ex. 26–1424).

Because these devices are used for treatment after an injury has occurred and because they are not intended to reduce exposure, OSHA finds that it would be inappropriate to consider back braces or wrist braces/splints as PPE under the final standard.

Paragraph (m)—What Steps Must I Take to Reduce MSD Hazards?

Paragraph (m) of the final rule establishes the steps employers must follow to reduce the MSD hazards in their jobs. The employer's obligation to control these hazards is established in paragraph (k); this paragraph (m) sets out the procedures to be followed and the timelines to be met to achieve the necessary hazard reduction.

The procedures in paragraph (m) are similar to those in proposed § 1910.919, although they have been revised in the final rule to reflect the Action Trigger and to state what employers must do if the controls they have implemented are not effectively reducing MSD hazards. The steps specified in paragraph (m) are widely recognized as basic procedures in effective control selection and problem-solving. For example, the NIOSH publication, *Elements of Ergonomic Programs,* describes a similar process (Ex. 26–2). Paragraph (m) also sets the deadlines for the implementation of initial and permanent controls to reduce MSD hazards. OSHA received very few comments on the proposed control steps provision.

The corresponding provision in the proposal also contained a requirement that employers identify and evaluate MSD hazards when they changed, designed, or purchased equipment or processes in problem jobs. The final rule contains no similar requirement.

OSHA does not believe that a separate provision is necessary, because the final rule includes a ''feedback'' loop between paragraph (m)(4) of the rule and paragraphs (m)(1) and (m)(2). OSHA received only one comment on this proposed provision (Ex. 32–300–1). This commenter asked whether OSHA intended this provision to be similar to the management of change provision in the Process Safety Management standard (29 CFR 1910.119). Since this proposed provision has not been carried forward in the final rule, the issue raised by this commenter is moot.

Paragraph (m)(1)—Ask Employees

This paragraph requires employers who have determined that they have a problem job to ask the employees in the problem job, and employee representatives, to recommend measures to reduce the MSD hazard in the job. This provision is essentially unchanged from the proposal, except that employee representatives are mentioned specifically in the regulatory text, which reflects OSHA's decision to add this language to provisions of the regulatory text where the involvement of employee representatives is particularly important. Several commenters (see, *e.g.,* Exs. 32–339–1, 32–182–1) urged OSHA to include employee representatives in this step of the hazard identification and control process because of the contribution they could make. OSHA agrees and has revised the text accordingly.

Asking employees and their representatives for recommendations of controls that will reduce MSD hazards is an effective and efficient way of solving ergonomic problems. Many commenters (see, *e.g.,* Exs. 3–112, 3–164, 30–3765, 30–3748, 500–137, 500–220) reported that the employees who are doing the job are usually the best source of information on the tasks causing the hazard and ways of solving the problem. For example, the American Health Care Association stated:

> Employers and employees who work in the industry are in the best possible position to identify risk factors in their workplace and to develop prevention methods that concentrate on the significant problems unique to their particular industry's environment (Ex. 3–112).

In many problem jobs, employees and their representatives will be able to pinpoint the problem quickly and to suggest easily adopted controls. In many cases, the solution will become obvious at the job hazard analysis stage; many problems also can be addressed with simple, off-the-shelf controls. Examples are:

- Eliminating awkward postures (such as bending when leaning across the workstation to reach a tool) by putting blocks under a work bench to raise the work surface height.
- Eliminating awkward postures of the neck and reducing stress on the back by putting packages of copy paper under a VDT monitor to raise it or taking the VDT off the CPU to lower it.
- Reducing awkward postures of the neck by moving the light source or removing the light bulbs that were causing glare on the VDT monitor screen.
- Reducing force by cleaning thread from the wheels of a cart that has been hard to push. (Many of these controls would qualify for the Quick Fix option (see paragraph (o).)

Some commenters (see, *e.g.,* Tr. 63354, 9038, 12647), however, were concerned that consulting with employees and their representatives could lead to disagreements about the controls selected. OSHA's experience, and comments to the record (see, *e.g.,* Exs. 3–112, 26–5, 30–3765, 30–3748, 500–137, 500–220, 500–218), do not suggest that this is a problem. Instead, these commenters point to the value of employee input. OSHA expects, however, that employers will use their management experience and judgment to resolve any disagreement that may arise. As is the case for all OSHA standards, the employer is clearly responsible for selecting controls and evaluating their effectiveness.

Another commenter (Ex. 32–300–1) argued against involving employees in the problem-solving and control identification process on the grounds that doing so might disappoint the employees if their suggestions were not taken. OSHA's experience suggests just the opposite, *i.e.,* that nothing disappoints employees more than not being part of a process that affects their working conditions so directly. Some employers also report that they bring their in-house resources (ergonomics committee members, safety and health professionals, ergonomists) into the process at this stage (see, *e.g.,* Exs. 26–1370, 502–17).

Paragraph (m)(2)—Initial Controls

This provision requires employers to identify and implement initial controls (referred to as ''interim'' controls in the proposal) to reduce MSD hazards within 90 days of the time the employer determines that the job is a problem job. Because the final rule allows employers to choose from engineering controls, administrative controls, work practice controls, and—as a supplement to these controls—personal protective equipment, OSHA believes that employers will be able to meet this timetable, which is essential to the protection of employees in problem jobs. OSHA anticipates that many employers, particularly those whose jobs can be controlled with off-the-shelf controls, will simply implement permanent controls within 90 days and be done with it. Others, however, will develop a plan and timetable for permanent control implementation and may need the full 4 years (2 years after the standard has been in effect for some time) to reach the control levels specified in paragraphs (k)(1) or (k)(2) of the final rule.

For these employers, the implementation of initial controls will generally mean a greater reliance on administrative controls, work practices, and, in those situations where personal protective equipment is effective, on PPE, in the period between the 90-day deadline in paragraph (m)(2) and the permanent control compliance deadline in paragraph (m)(3). OSHA recognizes that initial controls may not, in all cases, reach the control levels required by paragraph (k)(1) or (k)(2) for permanent controls; nevertheless, employers are required to make good faith efforts to address problem jobs promptly to protect the employees in them.

OSHA expects employers to implement initial controls that will substantially reduce employee exposure to the risk factors that are contributing to the MSD hazard. For example, employers might provide employees required to manually carry loads from one point to another with a cart or a hand dolly as an initial control, or they might reduce the weight of the object being carried while waiting to install a permanent conveyor system. In other cases, an employer might decide to implement a system of employee rotation while waiting to install new power tools throughout the plant. Other examples of controls employers often implement initially and then replace with more permanent controls later are the provision of tools with longer handles when excessive reaching is involved, anti-fatigue mats and sit-stand stools when excessive standing is the problem, and vibration-reduction gloves while waiting for new power tools with lower vibration levels to be installed. By substantial reduction, OSHA means that the initial controls must reduce the MSD hazard materially by decreasing the magnitude, frequency or duration of the employee's exposure to the relevant risk factors. Examples of controls that would not meet the employer's obligations under paragraph (m)(2) would be decreasing the weight of a package that is manually lifted from 90 to 85 pounds (because both weights substantially exceed the weight an employee should lift alone) or rotating employees into a second job that has the same risk factors (because this would not reduce the magnitude or duration of exposure).

The purpose of paragraph (m)(2) is to ensure that the employer takes steps quickly (*i.e.,* no more than 90 days after the job is identified as a problem job) to reduce the exposures of at-risk employees (*i.e.,* those in jobs that have identified MSD hazards). Waiting until permanent controls are installed, which may take as long as 4 years, would leave these employees unprotected and increase the likelihood that another MSD incident will occur. The concept of initial controls (interim controls) is a well-established principle of worker safety and health protection and is incorporated in many OSHA standards, as one commenter noted (Ex. 26–1370).

Paragraph (m)(3)—Permanent Controls

This paragraph requires employers to identify and implement permanent controls that will achieve the hazard reductions required by paragraphs (k)(1) and (k)(2) of the standard. This provision is essentially unchanged from the proposal, except that it has been revised to reflect the final rule's objective compliance endpoints and the function of the action trigger.

There are many ways employers can identify permanent controls in addition to asking employees and their representatives for control ideas. These include:

- Asking other establishments in the company how they have solved a similar problem; many companies with OSHA corporate-wide settlements have found this approach useful (see, *e.g.,* Ex. 32–185–3).
- Asking the industry trade associations for suggestions (the food retail industry, for example, worked as a group to reduce package weights (Tr. 4948).
- Attending ergonomics conferences and trade shows.
- Talking to the company's insurance agent about solutions that have worked for other companies.
- Reviewing equipment catalogs (one commenter reported using this approach to identify mechanical alternatives to drum handling (Tr. 6981)).

Several commenters stated that employers are best positioned to choose their own sources of control information and ideas (see, *e.g.,* Exs. 30–434, 30–240, 30–133, 30–3122, 30–3284, 32–300–1), and OSHA agrees, except that employees in the problem job and their representatives must also be involved in the process, as required by paragraph (m)(1).

Employers have many control strategies to choose from when identifying permanent controls. The controls selected may be any one, or any combination of, engineering, work practice, or administrative controls. These controls may be supplemented by PPE, but PPE may not be used alone unless other feasible controls are not available (see paragraph (l) of the standard). Among the factors employers consider when selecting controls are:

- Which control achieves the greatest reduction in employee exposure to the MSD hazard
- Which is likely to be accepted and used by employees
- Which takes the least amount of time to implement
- Which achieves a substantial reduction in exposure at the lowest cost.

These criteria are included as examples only; the standard does not require employers to use these criteria because OSHA recognizes that employers will choose those factors to consider that are most appropriate to their workplace. The following chart lists many controls that may be appropriate to reduce employee exposure to the risk factors that are responsible for MSD hazards, depending on the circumstances of a particular workplace. This list is illustrative only; it is not exhaustive but is provided merely to show that there are often many different control approaches that will reduce the magnitude, duration, or frequency of risk factor exposure.

Ergonomic risk factors that may be present	Examples of controls
Force (Exertions)	Use powered tools Change pinch to power grip Use longer handle Use appropriate size handle Use powered lift assist Counterbalance the weight Use lift tables Reduce the weight of the object Ensure that the center of gravity of the tool is over the hand Use a fixture, clamp or jig Provide periodic tool or equipment maintenance
Force (Manual Handling)	Lighten the load Use lift assist Use lift table Place package in larger containers that are then mechanically handled Use two-person lift team Rely on gravity to move the object Reduce friction when objects must be pushed or pulled Reposition object closer to the employee Provide pallet or table that can be rotated

Ergonomic risk factors that may be present	Examples of controls
Force (Manual Handling)	Provide space so that the employee can move closer to the object Reduce the size of the object Slide the object closer before lifting Place objects to be lifted above floor level Use adjustable height tables Store heavy objects at waist height Put handles on the object Modify the process to eliminate or reduce moves over a significant distance Convey the object (*e.g.,* conveyor, ball casters, air) Use fork lifts, hand dollies, or carts Use appropriate wheels on carts (and maintain the wheels) Provide handles for pushing, pulling or carrying Arrange workstation so that work is done in front of the worker Use conveyors, chutes, slides, or turntables to change direction of the object Provide belt with handholds to assist in moving patients Provide gloves that assist in holding slippery objects Redesign the handling job to avoid movement over poor surfaces Use surface treated with anti-slip material or anti-skid strips Provide footwear that improves friction
Awkward posture	Provide workstation adjustability Raise/lower the worker's position Raise/lower the workstation Provide better mechanical advantage, such as with a longer handle Design task for smooth movements Redesign the flow of the workplace layout Reposition object to allow for a neutral posture Train workers to use less stressful postures Provide better access to machinery Rotate pallet or work surface Allow short breaks Position work in front of the worker Use a tool to extend the reach Provide lumbar support for a seated worker Provide workstation adjustability Provide tool holders Provide a strap on the tool handle to allow the hand to relax while maintaining control Provide sit/stand workstations Rotate workers to jobs that do not involve the same posture Provide anti-fatigue mats Provide foot rests
Repetition	Use power tools Distribute the work so that less time is spent at repetitious tasks
Contact stress	Attach a well-designed handle to the tool Wrap or coat the handle with cushioning and non-slip material Provide a handle that does not press into the palm Wear knee pads or palm pads Use a soft mallet for hand hammering
Vibration	Use low vibration tools Isolate source of vibration from the worker Maintain tools regularly

The final rule allows employers coming into compliance with the standard initially to take up to 4 years, if necessary, to implement permanent controls; this period is reduced to 2 years for employers who identify problem jobs more than 2 years after the standard's effective date. Several commenters (see, *e.g.*, Exs. 32–339–1, 32–185–3, 32–210–2, 30–3815, 32–368–1) were concerned with the proposed compliance deadlines for the implementation of controls. The final rule has extended the permanent control deadline to 4 years from the standard's effective date; this phase-in drops to 2 years after the standard has been in effect for 2 years. For OSHA's responses to the record on compliance deadlines, see the Summary and Explanation for paragraph (x). OSHA believes that these control implementation deadlines will provide smaller employers, and employers with more complex control requirements, the time they need to plan for, obtain, and implement permanent controls.

Paragraph (m)(4)—Track Progress

Paragraph (m)(4) of the final rule requires employers to make sure that the controls they have identified and implemented are reducing MSD hazards and have not unintentionally created new MSD hazards. This paragraph has been revised from the proposal to include additional steps employers must take if they discover that their controls are not achieving the levels required or have introduced new MSD hazards. The proposal, in contrast, simply required employers to track their progress but did not specify what they were to do if their controls were not working as planned.

OSHA believes that this paragraph is essential, for several reasons. First, unless employers follow up on their control efforts, they will not know whether they are protecting their employees and are in compliance with paragraphs (k)(1) or (k)(2) of the rule. Second, in establishments with many problem jobs and a job prioritization plan in place, ascertaining the effectiveness of controls is important to ensuring that the employer's abatement strategy is an effective one. Third, control effectiveness is the basis of any effective program, and thus plays a critical role in evaluating the elements of the program. For example, an evaluation of work practice controls is an excellent way of determining whether training in these controls has been effective.

This step of the control monitoring process requires employers to consult with employees in the problem job and their representatives to ensure that the controls have been effective in reducing the physical difficulties employees associated with the job. The standard does not require employers to use quantitative or qualitative measures to evaluate control effectiveness, but many employers use such methods. Examples of before-and-after approaches used over a longer (*i.e.*, 6-month) period include:

- Reductions in severity (measured as fewer days away from work)
- Reductions in the number of symptoms reported in a symptoms survey
- Reductions in workers' compensation costs
- Reductions in MSD incidence rates.

Methods used in shorter-term evaluations, *i.e.*, those conducted within 30 days, include talking with employees and their representatives and symptoms surveys. NIOSH (Ex. 26–2) recommends that employers wait at least 2 to 4 weeks after control implementation to assess the effectiveness of controls, because this period of time is often enough to allow employees to tell whether the situation has improved.

OSHA believes that the process of hazard identification, control selection, and control evaluation has been greatly facilitated by the fact that the final rule identifies objective criteria against which employers can measure the extent of the risk factors present and the effectiveness of their efforts to control or reduce the hazard. Employers are not required to use the hazard identification tools referenced in Appendix D–1 or provided in Appendix D–2, but they are free to do so. OSHA believes that employers will generally find that the greater certainty that results from the appropriate use of these tools enhances their ability to protect their employees and increase the employer's confidence that the standard's control endpoints are being met.

Paragraph (o)—May I Use a Quick Fix Instead of Setting up a Full Program?

Paragraph (o) of the final rule sets out alternative provisions that employers may follow in lieu of setting up a full ergonomics program. These alternative provisions are referred to as the Quick Fix approach. The Quick Fix option allows employers to control an MSD hazard quickly and more informally without, for example, conducting a complete job hazard analysis, setting up a training program or a periodic program evaluation process.

OSHA has included a Quick Fix option in this standard to provide compliance flexibility for those employers who have:

- Only a few isolated MSD hazards (that is, they have had one prior MSD incident in any job in which an MSD incident is reported after the effective date and only 2 prior MSD incidents in the workplace during the 18 months before the new MSD incident is reported), and
- MSD hazards that can be identified easily and addressed quickly (that is, they can fix the job within 90 days after the MSD incident is determined to meet the Action Trigger).

OSHA believes that the Quick Fix option is an efficient mechanism for providing ergonomic protection for employees, while at the same time reducing regulatory burdens for those employers who have only a few isolated problems.

The proposed rule also included a Quick Fix provision, which a number of commenters supported (*e.g.,* Exs. 30–3813, 30–3436, 32–210–1, 30–294, OR 326, 500–218, Tr. 2134, 13642). For example, one commenter stated, ''I think that the Quick Fix is an outstanding idea that will reduce the burden of this standard for many companies'' (Ex. 30–3436). Portland General Electric Company agreed:

> We believe that the *Quick Fix option is extremely valuable.* We operate on a system of early reporting and *effective individual case management,* to the benefit of both the employee and the company (Ex. OR 326).

Some employers said that they had implemented types of Quick Fix approaches in their workplaces (see, *e.g.,* Exs. OR 326, Tr. 14715–16).

A number of commenters maintained that the Quick Fix would not be helpful or would not work. For instance, Integrated Waste Services Association said: ''While the ''quick fix'' idea sounds reasonable, quickly 'fixing a problem job' is unrealistic and illusory'' (Ex. 30–3853). Some of these commenters said the Quick Fix approach would not reduce regulatory burdens for employers (see, *e.g.,* Exs. 30–3853, 30–2988, 30–3815). And the National Association of Manufacturers (Ex. 30–3815) said that the Quick Fix ''is next to meaningless for an establishment of any size.''

Other commenters were more optimistic about the Quick Fix concept, but said that changes were needed to make it more useful for employers. Kaiser Permanente, for instance, supported the Quick Fix idea as a ''practical and cost effective idea'' in principle, but argued that the proposed provision was too limited and too vague to be workable (Ex. 30–3934). Others said the proposed Quick Fix offered an ''inappropriately narrow opportunity'' and urged OSHA to allow more abatement time and allow more than one Quick Fix in any one job (Ex. 30–2988, 500–145). Some commenters, however, argued that allowing more than one Quick Fix in a job was not protective enough (see, *e.g.,* Ex. 30–2825, 32–182–1). In addition, AFSCME opposed extending the Quick Fix option this way because it would be ''encouraging a piecemeal and disjointed approach to ergonomics'' (Ex. 32–182–1).

On the other hand, some commenters were concerned that the proposed Quick Fix was not adequately targeted to those workplaces where such an approach would be appropriate. The AFL–CIO said:

> In our view, the quick fix provisions proposed by OSHA are more properly suited to those workplaces where the number of jobs with MSD hazards is limited and where there are few MSDs. In those situations, focused efforts to identify and correct hazards quickly may be the best solutions, and a full ergonomics program may not be needed (Ex. 32–339–1).

The AFL–CIO and others also identified specific high hazard workplaces in which the Quick Fix would not be appropriate, such as nursing homes, warehouses, automotive assembly plants, and meatpacking and poultry processing plants (Exs. 32–339–1).

OSHA has made a number of changes to the Quick Fix provision in this final standard to address these concerns. These changes include:

- Focusing the Quick Fix more carefully on those employers with limited MSD problems by specifying that it applies where there have been only 2 prior MSDs in the workplace in the past 18 months,

• Providing clearer criteria for hazard identification and control (*i.e.,* the Basic Screening Tool) and compliance ''endpoint'' (*i.e.,* the levels in Appendix D),

• Ensuring that employees receive training in using the implemented controls so that the Quick Fix is more likely to be successful, and

• Simplifying the criteria for determining whether a Quick Fix has been successful or has failed.

Paragraph (o)(1)

Paragraph (o)(1) defines which employers may avail themselves of the Quick Fix approach instead of implementing a complete ergonomics program. Employers may use the Quick Fix approach if, within the last 18 months:

• No more than 1 prior MSD incident has occurred in the job in which another MSD incident is reported, and

• There have been no more than 2 prior MSD incidents in the workplace as a whole.

This represents a change from the proposed rule, which would have allowed employers to use Quick Fix option in every job in the workplace, but only for the first MSD incident in that job.

OSHA believes that the changes in the final rule provide more compliance flexibility, and thus will allow more employers to take advantage of the Quick Fix option. First, changing the Quick Fix provision to allow employers to use it 2 times in the same job makes the option available for more jobs. Allowing 2 Quick Fixes in one job recognizes, as Kaiser Permanente pointed out, that the occurrence of a second MSD in the same job may not necessarily mean that a previous control measure has not worked, but rather that a different combination of risk factors may be present (Ex. 30–3934):

> [T]he conclusion in the proposed rule that the ''Quick Fix does not work'' if another MSD is reported in the same job within 36 months * * * wrongly assumes that the same fix should work for the same physical work activities and conditions. The fix that works for one employee's condition may not work for another because of that employee's physical characteristics or non-work related contributing factors. A second or third MSD in the same job does not mean the initial quick fix did not work, and employers should have the option to apply a quick fix to newly reported MSDs (Ex. 30–3934; see also Exs. 30–2088, 500–215).

Second, not restricting the 2 MSD incidents to ones caused by different risk factors, as the proposed rule would have done, will also make the Quick Fix option available to more jobs. Eliminating this restriction on the second MSD incident also addresses commenters' concerns that this provision was not clear enough to be workable (see, *e.g.,* Exs. 30–1349, 30–358, 30–595, 30–538, 30–323, 30–1022, 30–1551, 30–3745, 30–3723).

Third, halving the Quick Fix time frame to 18 months should make the Quick Fix option available to more employers because MSDs that occurred several years ago would not disqualify employers from using the Quick Fix option. In addition, it makes the Quick Fix option more attractive, as Kaiser Permanente noted:

> [F]or large employers, tracking MSDs to determine whether another covered MSD is reported in the same job within 36 months would be cumbersome (Ex. 30–3934). Organization Resources Counselors, Inc. (ORC), agreed:
>
> The proposed requirement that the employer establish a full ergonomics program if another similar MSD occurs in the job within 36 months is too rigid because the occurrence of MSDs is so closely related to individual worker characteristics. If the employer determines that additional feasible controls will eliminate the significant risk from that job for that worker, another quick fix should be permitted (Ex. 30–3812).

OSHA estimates that these changes should allow a large percentage of jobs, as high as 25 percent of all jobs meeting the Action Trigger, to be controlled using a Quick Fix. (See Chapter V of the Final Economic Analysis).

At the same time, limiting the Quick Fix option to employers who have only 2 MSDs in their workplace during the prior year and a half also helps to target more precisely the provision to those workplaces that have only isolated MSD problems. OSHA agrees with commenters that where only a few MSDs are occurring, employers may be able to address the problems effectively in an informal way, but that the occurrence of several MSDs in a workplace in just over a year ''may be indicative of a bigger problem'' that requires a more systematic approach to adequately address (Ex. 32–210–2).

Although OSHA believes that targeting the Quick Fix to workplaces with few isolated MSD hazards will likely make the option most useful to small businesses, larger employers may also find the Quick Fix a useful mechanism. For example, large employers who have ergonomics programs in some jobs would be free to use the Quick Fix option if an MSD hazard were identified in another job.

Paragraph (o)(2)

Paragraph (o)(2) of the final rule sets up the process that employers using the Quick Fix option must follow. Employers must use this process to fix the injured employee's job and all ''same jobs'' in the establishment. Although this process is informal and flexible, it nonetheless includes those basic steps that employers who have Quick Fix or ''quick response'' processes use (Ex. 32–198–4–27–1). This process includes:

• Providing prompt MSD management to the injured employee (paragraph (o)(2)(i));

• Talking with employees to identify those tasks they associate with the MSD incident (paragraph (o)(2)(ii));

• Observing employees performing the job to identify the risk factors likely to have caused the MSD incident (paragraph (o)(2)(iii));

• Asking employees for their ideas for reducing exposure to the MSD hazards (paragraph (o)(2)(iv));

• Implementing measures within 90 days to control or reduce the MSD hazards (paragraph (o)(2)(v));

• Training employees in using the controls implemented (paragraph (o)(2)(vi)); and

• Keeping records of the Quick Fix (paragraph (o)(2)(vii)).

These provisions of the final rule are similar to steps in the proposed Quick Fix, although they have been revised in some respects to respond to comments received.

Same Jobs

Also similar to the proposed rule, those employers who qualify for and select the Quick Fix option must fix not only the injured employee's job but also all other ''same jobs'' in the establishment. This requirement applies both to employers using the Quick Fix and to those who must implement ergonomics programs. Several commenters objected to requiring employers to apply the Quick Fix beyond the injured employee's individual job (see, *e.g.,* Exs. 30–2208, 30–2725, 30–3745, Tr. 9183). Some said having to fix all same jobs was not necessary and would impose excessive cost. For example, the Center for Office Technology (Ex. 30–2208) stated:

> The Quick Fix section is worded so that if one office worker is experiencing discomfort and his workstation is changed—the example given is purchasing an adjustable workstation for a VDT operator—all the ''same job'' employees at that worksite would also have to get an adjustable workstation when in fact no other employees may need them.

OSHA believes this requirement is necessary because it helps to ensure that other employees performing the same physical work activities and exposed to the same MSD hazards are provided with protection before they too get hurt. In this sense, the ''same job'' requirement helps to make the final rule more proactive and preventive. OSHA believes that controlling other same jobs will also be cost-effective for employers because it is only a matter of time, in jobs meeting the Action Trigger, until another MSD incident occurs.

For several reasons, OSHA does not believe that the ''same job'' requirement will impose an undue burden on employers. First, OSHA believes that the number of ''same jobs'' in the establishments likely to use the Quick Fix option will be small, because OSHA believes that many qualifying employers will generally be small businesses. Second, the final rule allow employers to limit the Quick Fix to the injured employee's job where the employer has reason to believe that the risk factors in the job only pose a problem to the injured employee. (See note to paragraph (j).) Thus, if the case referred to by COT (Ex. 30–2208) meets the requirements described in the note to paragraph (j), the employer would only be required to fix that employee's job. This provision was included in the proposed rule, and a number of commenters supported it, saying that such an exception was needed because the individual characteristics of one worker may require controls that don't work for or are not needed by other workers (see, *e.g.,* Exs. 30–3745, 30–358).

Finally, even where there are ''same jobs'' that also must be Quick Fixed, OSHA does not believe that the Quick Fix process will be burdensome for employers. The Quick Fix process is very informal and thus provides employers with great flexibility in complying with each step in the Quick Fix process. In addition, the final rule allows employers to include a sample of employees, rather than all employees in the same jobs, in the hazard identification and solution consultation process. OSHA agrees with commenters that allowing employers to rely on a sample of the employees who are likely to have the greatest risk factor exposure in the job should help reduce burdens for large employers and for employers with many employees in the same job (Ex. 30–2208).

1. Provide MSD Management

Like employers who must implement an ergonomics program, employers who select the Quick Fix option must provide the injured employee with prompt MSD management after they have determined that an MSD incident has occurred and the job meets the Action Trigger. This includes providing the injured employee with access to an HCP and work restrictions during the recovery period, if necessary. Where work restrictions are needed, employers who select the Quick Fix option also must provide the work restriction protection (WRP) that this standard requires. (For further discussion of MSD management requirements, see summary and explanation for paragraphs (p), (q), (r), and (s) below.)

2. Talk With Employees

Paragraph (o)(2)(ii) requires that, as part of the process of identifying the MSD hazards, employers using the Quick Fix option must at least to talk with the employees in the job (and their representatives). The purpose of this consultation is to ensure that employers ask those who know the most about the job-those that perform it-for their help in identifying the physical work activities and job conditions that they believe are mostly likely to be associated with the MSD incident. OSHA believes that including this step in the Quick Fix process will help employers more quickly and fully identify the problem so they will have the chance to fix the problem within the Quick Fix deadline.

Many commenters agreed with the importance of including employees in the hazard identification process (see, *e.g.,* Exs. 500–200, 500–215, 30–1100, Tr. 3565). The record consistently shows that employers with effective ergonomics programs consult with their employees because employees know what tasks are contributing to their MSD signs and symptoms and because they often have the best and least expensive ideas for solutions (Exs. 30–1100, 500–200, 500–215, Tr. 14903, Tr. 3062). Talking to other employees who perform the same job as the injured employee also provides employers with an opportunity to identify the problems with the job more fully, and this, in turn, will help ensure that the right solutions will be found to address the problem.

3. Observe the Job

Paragraph (o)(2)(iii) specifies that employers must observe employees performing the job to identify the MSD hazards that caused the MSD incident. This step helps to ensure that nothing has been overlooked in the discussion with employees. In addition, as several commenters have pointed out, often problems in jobs become readily apparent as soon as the person responding to the report has an opportunity to watch employees performing the job (Exs. 30–3436, 26–2, Tr. 1038).

To provide employers with maximum flexibility in complying with this step, paragraph (o)(2)(iii) allows employers to select the method of job observation that works best for the conditions in their workplace. For example, employers may simply watch employees perform the job; videotape the job; or use a simple checklist, such as the VDT checklist in Appendix D–2 or checklists similar to the one developed by the Dow Chemical Company (Ex. 32–77–2–1). In addition, employers are free to determine in what order they want to conduct the steps of the Quick Fix process. Some commenters said that they observe the job first as a way to better focus their discussions with employees.

4. Ask Employees for Solutions

Paragraph (o)(2)(iv) specifies that employers using the Quick Fix option must ask employees in the problem job for their ideas to fix the job. OSHA has included this step in the Quick Fix process because time and again employers have said that their employees often come up with the best and least expensive solutions to problems (Tr. 8725, 1160, 9508). For example, PPG stated that:

> We [management] do not have to look over their shoulders to make sure that they are implementing every—dotting every I. And it is a successful program. Essentially, the workers run it (Tr. 3062).

This step also was included in the proposed Quick Fix. Some commenters asked OSHA to clarify whether employers were obligated to implement the recommendations that employees make (Ex. 30–595). The requirement that employers ask employees for their recommendations does not limit them to implementing only those solutions recommended by employees. OSHA expects employers to use their judgment when responding to employee suggestions and to select controls that will achieve the reduction in MSD hazards mandated by the rule. OSHA notes that the records shows that employee suggestions for ergonomic improvements are often both practical and effective.

5. Implement Controls Within 90 Days

Paragraph (o)(2)(v) of the final rule requires employers, within 90 days, to implement measures that either:

- Control the MSD hazards (*i.e.,* reduce hazards to the extent that they are no longer reasonably likely to cause MSDs requiring days away, work restrictions or medical treatment), or

• Reduce the hazards to the levels indicated in the appropriate hazard identification tool in Appendix D.

Employers must put controls into place within 90 days of the time the employer determines that the job meets the Action Trigger. Employers are free to use any combination of engineering, work practice or administrative controls to fix the job. As part of the Quick Fix, employers must also train employees how to use the controls that have been implemented.

Implement Controls

The proposal would have allowed employers to use the Quick Fix option only where they could ''eliminate MSD hazards,'' which was defined as controlling physical work activities and conditions to the extent that an MSD was not reasonably likely to occur, which was a higher level of control than for employers who were implementing full ergonomics programs. Several commenters opposed the proposed Quick Fix control endpoint, generally saying that it was either too vague to be workable or impossible to attain (see, *e.g.,* Exs. 30–4290, 30–3812, 30–2208, Tr. 2998, 8394, 9182). The comment of ORC was typical of this opposition:

> One fundamental change that must be made to this provision is the revision of the proposed requirement to eliminate MSD hazards; the formulation is problematic and may be legally impermissible. It is well established that employers may only be required to take technologically and economically feasible abatement measures. The second problem is that employers cannot be required to establish a risk-free environment, so that to the extent that the terms ''eliminate MSD hazards and eliminate employee exposure'' suggest that an employer must go beyond reducing the significant risk of harm in a particular instance, these terms must be revised and clarified (Ex. 30–3812).

OSHA believes that the changes in this provision address the commenters' concerns. The final rule's Action Trigger helps to ensure that employers will only have to take action in higher-risk jobs. As mentioned in the summary and explanation for paragraph (f), jobs that meet the Action Trigger (*i.e.,* exceed the exposure levels in the Basic Screening Tool) are ones that generally pose a risk of MSDs that is three times higher than those that do not. Second, the control endpoints employers must meet under the Quick Fix option do not require the elimination of all risk. For example, employers will be considered in compliance with the Quick Fix control requirement if they reduce exposure levels to below those in Appendix B of Washington State's ergonomics rule. The acceptable exposure levels in the Appendix B are almost twice as high as those in the Basic Screening Tool. Thus, the standard does not require employers to achieve a ''risk-free environment.'' Third, the Quick Fix now contains more specific criteria for identifying and controlling hazards so that employers more clearly understand when a hazard is present and when they have done enough to fix the job. Thus, the final rule is not requiring employers to take ''technologically or economically'' infeasible abatement measures.

90-day Control Time Line

The final rule continues the proposed 90-day time line for implementing Quick Fix controls, but now specifies that the time begins to run only after the employer has determined that the job in which the MSD incident occurred meets the Action Trigger. Comments on the proposed 90-day time line were mixed. Some commenters testified that many MSD hazards can be controlled quickly (see, *e.g.,* Exs. 30–3813, 30–3436, 32–210–2, 30–294, Tr. 13642, Tr. 2134), while others said that controls, especially engineering controls, could not be implemented in 90 days (see, *e.g.,* Exs. 30–3815, 30–240, 31–307, Tr. 4628, 30–3853, 30–1091, 30–1048). As a result, some commenters requested that OSHA provide extended abatement time for employers who could not implement Quick Fix within the allotted time frame (Ex. 30–3853).

For several reasons, OSHA believes that the Quick Fix deadline should not be extended. First, OSHA believes that extending the deadline negates the principle underlying the Quick Fix concept. Second, OSHA believes that controls that take longer than 90 days to implement indicate that the problem may be more complex than originally anticipated, and therefore, may more appropriately be addressed in the context of a comprehensive ergonomics program.

Third, OSHA does not believe that extending the 90-day Quick Fix deadline is necessary, because the record shows that there are many controls that can be implemented quickly to control or reduce MSD hazards. Many of these are obvious and low-cost fixes that can be made to workstations (*e.g.,* raising or lowering work surface or chair, placing equipment directly in front of an employee to eliminate extended reaches or awkward postures, providing a platform or box to stand on as a way to eliminate overhead reaching, putting reams of copy paper under a monitor as a way to eliminate awkward neck postures), tools or equipment (*e.g.,* servicing of powered hand tools, changing the way bags move on a conveyor), and work schedules (*e.g.,* rest breaks, job rotation, job enlargement) (see, *e.g.,* Tr. 2147, 6510). One participant discussed the effectiveness of these types of Quick Fix adjustments in office environments:

> If you're looking, say, at the office environment, the quick fix situation is very often the one that's there in any case, because you're looking at people who need improvements to their posture and so on and so forth. And very often, the whole work environment is already there to be adjusted. It just needs a quick-fix, which in this case is often training and showing people how they should be adjusting their workstation for their particular tasks. So very often, in the office environment, the quick fix is the only way to do it. (Tr. 2707)

The record also includes information on a wide variety of inexpensive ''off-the-shelf'' controls and technology that can be put into place quickly. Some of these measures include telephone headsets; foot rests; ''anti-fatigue'' mats or other cushioned surfaces; monitor risers; wider grips for hand tools; knife sharpeners; and carts and other mechanical devices to assist with lifting, pushing, pulling and carrying tasks (Tr. 3946). According to David Alexander, a certified professional ergonomist and president of Auburn Engineers, one reason why ''off-the-shelf'' controls can be implemented so quickly and inexpensively is that they do not require ''custom engineering'' (Ex. 37–12). In addition, Mr. Alexander said that many of these controls can be easily identified and purchased by looking at equipment catalogs, calling regular vendors, contacting trade associations, and even searching the Internet (Ex. 37–7). For example, he said that the Job Accommodation Network, a free service offered by the President's Commission on Employment of People with Disabilities, has ''a huge database of specific solutions to accommodation problems,'' many of which are also solutions to ergonomics problems, that are available to anyone who calls the network's toll-free number (Ex. 37–12). In addition, many other examples of quick and inexpensive fixes are in the cost chapter (Chapter V) of the final economic analysis.

Finally, the fact that employers are free to Quick Fix hazards using any combination of engineering, work practice and administrative controls also supports the 90-day time line. Administrative controls, in particular, should not take long to implement. And employers would be free to Quick Fix jobs with administrative controls initially and later substitute engineering controls when they become available.

In addition to requests for more time to Quick Fix jobs, at least one commenter urged OSHA to delay the start of the 90-day Quick Fix deadline until after the MSD incident has been confirmed by the employer's HCP and perhaps even an ''independent'' HCP, the employee's medical history has been evaluated, and diagnostic measures have been conducted (Ex. 30–3853). Paragraph (e) already allows employers to consult with an HCP in determining whether an MSD incident has occurred. In addition, after that determination is made, employers have another 7 days in which to determine whether exposure levels in the job exceed the levels in the Basic Screening Tool before the 90-day control time begins to run. Nonetheless, OSHA believes that, in the overwhelming number of cases, employers rather than HCP's will make the determination about the work-relatedness and seriousness of the reported MSD, as they have done for years in the context of the recordkeeping rule. Therefore, OSHA does not believe that initiation of the control implementation deadline needs to be delayed.

Finally, one commenter asked OSHA to clarify whether the Quick Fix option could be used in jobs that do not last for 90 days (Tr. 12179). OSHA is not clear whether the commenter was referring to (1) the same short duration job that is repeated (*e.g.,* seasonal work, temp agency work assignments) or (2) one-time job of short duration (*e.g.,* special project). OSHA realizes that where an MSD occurs toward the end of a short duration job that there may be some limits on what measures the employer may be able to take, that is, the employer may not have enough time to fully implement either a Quick Fix or an ergonomics program. Nonetheless, the employer must still implement those measures, such as interim controls, that are feasible to implement during the remaining time. (See summary and explanation for paragraph (m) for discussion of the term ''interim controls.'') In addition, where the short duration job is repeated on some regular or foreseeable cycle, such as seasonal fish processing, each cycle is, in essence, a serial ''same job.'' As such, in order for employers to use the Quick Fix option in these situations, they will be required to have controls in place before the next job cycle begins.

Control Training

As part of the requirement to fix jobs, paragraph (o)(2)(v) also requires employers to train employees in jobs that are Quick Fixed so that they know how to use the controls that have been implemented. OSHA added this provision after commenters pointed out that Quick Fix controls may not be successful, and therefore employees may not be protected from MSD hazards, if they do not know how to use those controls correctly (see, *e.g.,* Exs. 32–339–1, Tr. 6985). In fact, a number of employees who testified at the hearings reported that, although they had been provided with ergonomically appropriate controls (*e.g.,* adjustable chairs), they had never been taught how to properly use or adjust the controls (see, *e.g.,* Tr. 8461).

6. Check Success of the Controls

Paragraph (o)(2)(vi) requires employers, within 30 days after implementing Quick Fix controls, to review the job to determine whether the measures implemented have controlled the hazards or reduced them to the levels in Appendix D. An analogous provision also was included in the proposed rule. A number of commenters complained that a 30-day time line for checking the success of the Quick Fix controls was too short (see, *e.g.,* Exs. 31–307, 30–240, 30–3815, 30–3853, 30–2988, 30–3934, Tr. 4628). For example, Kaiser Permanente said:

> If a person has serious MSD symptoms, the symptoms may not subside in this short time. Kaiser Permanente recommends that OSHA modify the proposed Quick Fix deadline for elimination of the MSD hazard to 120 days from the date of implementation of the hazard controls.

Likewise, the Tennessee Valley Authority expressed concerns that 30 days might not be long enough to evaluate control effectiveness (Ex. 31–307).

For several reasons, OSHA believes that 30 days provides employers with sufficient time to check up on whether the controls have been successful. In its Elements of Ergonomics Programs, NIOSH said that evaluations of control effectiveness should be made within 2 to 4 weeks of control implementation. NIOSH's concern was not that 30 days was too short a period of time for conducting post-implementation followup, but rather with checking up on controls too quickly:

> Because some changes to work methods (and the use of different muscle groups) may actually make employees feel sore or tired for a few days, followup should occur no sooner than 1 to 2 weeks after implementation, and a month is preferable. Recognizing this fact may help avoid discarding an otherwise good solution (Ex. 26–2).

At the same time, if controls are not working and the employer is allowed to wait for an extended period of time before checking up on the job, the injured employee's condition may worsen. Retaining the 30-day followup helps to ensure that employers initiate further and more comprehensive action to prevent the employee from suffering permanent damage or disability. In any event, OSHA believes that the availability of various tools and checklists as well as the final standard's more clearly-defined control endpoints will make the control evaluation process easier and quicker.

7. Keep Records of the Quick Fix

Paragraph (o)(2)(vi) specifies that employers must keep records of their Quick Fixes for 3 years, or until replaced with updated records. Paragraph (v), however, limits the recordkeeping requirement to employers with 11 or more employees. This provision was included in the proposed rule. While some commenters agreed that such records were necessary (Ex. 30–710), several commenters opposed this requirement (see, *e.g.,* Exs. 601–X–1, 30–3755, 30–1019, 30–294, 30–3745, Tr. 2983, Tr. 5758). Some said the recordkeeping requirement would be burdensome, especially for small businesses. The Office of Advocacy of the Small Business Administration (Ex. 601–x–1) submitted the following comment:

> The Quick Fix option also limits the one small business exemption which exists within the ergonomics program standard proposal. This option states that an employer must keep records of the Quick Fix controls they implement, when they are implemented and the results of any evaluations. [The Office of Advocacy of the SBA] strongly recommends that the language within this option be clarified to indicate that employers with less than ten employees do not need to keep records for any provision in the standard. Without this clarification, the option is not a real one for small business and will have the [effect] of mandating compliance with the total rule for employers with less than ten employees.

Paragraph (v) of the final rule does not require employers with fewer than 11 employees to keep records, including Quick Fix records.

Other commenters said that the recordkeeping requirement added unnecessary complexity to the Quick Fix option. For example, Dow Chemical Company (Ex. 30–3755) stated:

> The use of this provision should be such that it encourages its use in order to take advantage of the fact that it exempts an employer out of the full rigors of the ergonomic program rule. To insist on, for example, recordkeeping of the quick fix controls will be a disincentive to its use and thus may defeat its purpose. To require that such documentation be retained for three

years is absurd. [Dow] * * * suggests 45 days or until the ''quick fix'' is implemented and results validated.

OSHA believes that records are necessary where employers substitute one-time action for a comprehensive approach to controlling MSD hazards. First, the Quick Fix option does not include the ''checks and balances'' of a comprehensive program (*i.e.,* management leadership, employee training, and program evaluation). Second, employers who use this option will need these records to demonstrate that the Quick Fix process has been successful in controlling the hazards. In addition, employers themselves need records to be able to demonstrate that they continue to qualify for using the Quick Fix option. Finally, OSHA believes that keeping the Quick Fix records for just 3 years will not pose a burden for employers, especially since these employers will not have to put resources into keeping the other records that employers who have full ergonomics programs must maintain.

Paragraphs (o)(3) and (o)(4)

The last two provisions of the Quick Fix process provide that employers are not required to take additional action as long as the job hazards remain controlled or exposures do not exceed the levels in Appendix D. As long as these control levels are maintained, employers need only provide training in the use of the controls to new employees who are assigned to Quick Fixed jobs. If, however, hazards cannot be reduced to those levels within the Quick Fix time frame, or be maintained at those levels, employers must implement an ergonomics program in that job, *i.e.,* if more than one MSD incident has already occurred in the job. However, if this is the first Quick Fix in that job, the employer would be free to repeat the Quick Fix to see if a second effort might be more successful.

The proposed rule, on the other hand, would have adopted a ''wait and see'' approach, requiring employers to implement a full ergonomics program if it turned out that the controls did not eliminate the hazards with the deadline or if another MSD occurred in the job sometime during the following 36 months. The proposed rule would have provided one exception to moving onto a full ergonomics program in those cases where the second MSD incident in the job was caused by different risk factors.

Several participants commented on this proposed provision (see, *e.g.,* Exs. 30–3813, 30–3815, 30–710, 30–1107, 30–494, 30–4540, Tr. 14985). Most commenters (see, *e.g.,* Exs. 30–3813, 30–3815) argued that the 36-month ''wait and see'' period was too long. OSHA has responded by reducing the ''wait and see'' period to 18 months. This means that employers continue to qualify to use the Quick Fix option if no more than 2 MSD incidents have occurred in the past 18 months. MSD incidents that occurred more than 18 months previously would not be considered in determining whether the employer could continue to use the Quick Fix option in that workplace.

MSD Management and Work Restriction Protection

Paragraphs (p), (q), (r), and (s) of the final rule set forth the final rule's requirements for MSD management and work restriction protection (WRP). These provisions require employers to set up a process to manage MSD incidents when they occur. OSHA's final rule requires that employers make MSD management available promptly to workers in jobs that meet the action trigger whenever an MSD incident occurs; provide this MSD management at no cost to the employee; provide temporary work restrictions and ''work restriction protection'', and provide a mechanism for multiple health care professional (HCP) review when health care providers disagree about the proper course of action the employer should take. The discussion of these sections is divided into two parts; the first section discusses MSD management, and the second, worker restriction protection and multiple HCP review.

MSD Management

Under the final rule, employers would be required to make MSD management available promptly whenever an MSD incident occurs; provide this MSD management at no cost to the employee; and evaluate, manage, and follow-up on the MSD incident. Specifically, employers are required by the final rule to:

- promptly provide effective MSD management at no cost to the employee,
- provide employees with access to a health care provider (HCP),
- provide work restrictions the employer or the HCP find necessary,
- provide the HCP with information about MSD management and the employee's job,
- obtain a written opinion from the HCP about the MSD,
- provide the employee with the HCP's opinion, and
- evaluate, manage and follow-up on the MSD incident.

The final rule's MSD management provisions are quite similar to the provisions in the proposed rule. The final rule differs from the proposed rule section in the following ways:

- MSD management is provided under different circumstances (only when a worker has an MSD incident and the job rises above the action trigger),
- MSD management is no longer described as being for the purpose of ''to prevent their (the employee's) condition from getting worse'',
- the employer is not required to determine the need for work restrictions or other actions before consultation with a health care provider,
- the employer must provide slightly different information to the health care provider,
- the health care provider is not afforded a right to walk through the employers workplace,
- minor editorial changes to the numbering, language and sequence of the requirements to simplify the sections and reduce duplication, and
- changes to the work restriction protection (WRP) requirements reducing WRP payments from 6 months to 3 months, and allowing the use of sick leave during the WRP period.

These changes reflect OSHA's review and analysis of the many comments and other evidence in the record pertaining to MSD management, which are discussed below. OSHA also asked for input on several specific issues in Section XIV of the proposal, Issues on Which OSHA Seeks Comment. The comments provided in response to those questions are included in the discussion of the relevant issues below.

Is MSD Management Needed?

OSHA received many comments on the proposed MSD management section. Many commenters generally supported the inclusion of MSD management provisions in the standard (see, *e.g.,* Exs. 30–626, 30–651, 30–2387, 30–3033, 30–3034, 30–3035, 30–3258, 30–3259, 30–3686, 30–3813, 30–3826, 30–4538, 30–3934, 30–4159, 30–4468, 30–4536, 30–4538, 30–4547, 30–4549, 30–4562, 30–4627, 30–4776, 30–4777, 30–4800, 31–23, 31–31, 31–43, 31–71, 31–92, 31–105, 31–113, 31–150, 31–156, 31–160, 31–161, 31–163, 31–186, 31–229, 31–243, 31–259, 31–301, 31–309, 31–342, 31–345, 31–347, 32–182–1, 32–210–2, 32–339–1, 32–85–3, 32–111–4, 32–133–1, 32–450–1, 30–4468, DC 75, 30–1104, L–30–4860, 37–12, 37–28).

Several commenters stated that MSD management is an essential component of an ergonomics program. For example, Lieutenant Colonel Mary Lopez, of the Department of Defense, reported at the hearing that healthcare management (*i.e.,* MSD management) is a critical element in any ergonomics program (Tr. 3221, Ex. 30–3826–14, 500–218). The 3M Company stated that ''The need for effective MSD management is universally accepted'' (Ex. 30–3185). Dr. Robert Harrison stated that ''The medical and scientific literature and my own clinical experience confirm that MSD management is an essential part of an ergonomics program'' (Ex. 37–12).

Evidence in the record shows that many companies, through early intervention and the effective management of MSDs, have achieved substantial reductions in the number and severity of MSDs, which have in turn, translated into less lost-work time, fewer lost-workdays, lower costs per case, and fewer workers' compensation claims (see, *e.g.,* Exs. 3–56; 3–59; 3–73; 3–95; 3–113; 3–118; 3–147; 3–175; 3–217; 26–23, 26–24, 26–25, 26–26, 30–3185, 500–20–3, 500–71–84, Tr. 14357, Tr. 14721, Tr. 17431). Representative of these comments, Dr. Colin Baigel of the Bristol Myers Squibb Company reported at the hearing that ''[o]ne of our keys is early medical intervention with any sorts [of] symptoms or signs of physical illness'' (Tr. 10516). He commented further that, in his company's program, they see and evaluate employees early, modify the workplace, and institute aggressive conservative treatment if necessary (Tr. 10516).

North Carolina State University discussed the consequences of not providing prompt MSD management, stating that ''I know of employees who were ordered by a non-medical supervisor to get back to work after an injury—in each case the lack of immediate medical care exacerbated their conditions'' (Ex. 31–163)

Several commenters recommended that OSHA strengthen the provisions of this section to achieve early detection and a more proactive approach to MSD management (see, *e.g.,* Exs. 30–626, 30–2387, 30–4583, 32–182–1, 32–339–1, L–30–4860, 500–71–86, 500–218). Many suggested that MSD management should be triggered when an employee reports the signs and/or symptoms of MSDs (see, *e.g.,* Exs. 30–3686, 30–4538, 32–111–4, 32–182–1, 32–339–1, 32–210–2, 32–461–1, 32–85–3, L–30–4860). For example, the American Public Health Association stated that MSD management should be required for *all* MSDs reported to the employer including symptoms of MSDs (Ex. 30–626). The AFL–CIO (Ex. 32–339–1) argued that, as proposed, the MSD management provided by the proposed standard would not achieve the goal of early detection and urged OSHA to rely on employee reports of persistent signs and symptoms to trigger MSD management for all jobs, rather than relying on covered MSDs to trigger action in some jobs, as the proposal did. Others recommended using an even more proactive, risk-based approach to trigger MSD management, instead of waiting for an employee report of an MSD (see, *e.g.,* Exs. 30–626, 30–2387, 30–3686).

Several commenters supported the proposed MSD management provisions with reservations/concerns (Ex. 30–3185, 30–3188, 30–4777). For example, the American Occupational Therapy Association urged OSHA to ''[p]rovide guidance about the difference between treatment of a disorder and the management of early symptoms'' (Ex. 30–4777).

Other commenters opposed the approach to MSD management taken in the proposal (see, *e.g.,* Exs. 30–276, 30–400, 30–1090, 30–1294, 30–1350, 30–1357, 30–1370, 30–1722, 30–1727, 30–1989, 30–2037, 30–2208, 30–2216, 30–2435, 30–3032, 30–3167, 30–3200, 30–3284, 30–3344, 30–3368, 30–3392, 30–3677, 30–3765, 30–3845, 30–3853, 30–3867, 30–3956, 30–4040, 3–4046, 30–4185, 30–4470, 30–4499, 30–4564, 30–4567, 30–4837, 30–4839, 30–4843, 31–27, 31–77, 31–78, 31–79, 31–125, 31–135, 31–172, 31–180, 31–202, 31–220, 31–225, 31–227, 31–245, 31–246, 31–247, 31–248, 31–252, 31–253, 31–265, 31–280, 31–283, 31–286, 31–307, 31–319, 31–321, 31–337, 32–120–1, 32–300–1, 500–1–127, 500–177–2, 500–208). In a representative comment, PPG industries recommended that OSHA

> Remove these sections completely. These are very onerous requirements and the cost estimates of OSHA for these issues do not begin to approximate the real costs to industry to comply with these provisions. Further, they do nothing to achieve improved ergonomics in the workplace (Ex. 500–177–2).

Some of these commenters objected to the proposed MSD management section because it included provisions protecting the wages and benefits of injured workers (see, *e.g.,* Exs. 30–240, 30–3813, 30–3765, 30–3845, 601–x–1). These comments are discussed in detail below in conjunction with the comments received on the proposed rule's provisions on work restriction protection. Other commenters objected for the following reasons:

- The proposed provisions exceed OSHA's legal authority (see, *e.g.,* Exs. 30–710, 30–1350, 30–3956, 30–1722, 30–2208, 30–3765, 30–3845, 30–3956, 30–4499, 31–319, 32–241–4);
- The proposed provisions are unnecessary (Exs. 30–3677, 30–3765, 30–4185, 500–177–2); employers already have systems in place for medical management of all injuries (Exs. 30–3677, 30–3765, 30–4185, 31–79, 31–321, 500–177–2);
- Medical management is addressed in other OSHA standards (1910.151 Medical services and first aid.) (Exs. 30–3765);
- The proposed provisions add burden on employers (see, *e.g.,* Exs. 30–1294, 30–3765, 30–4040, 30–4499, 30–4564, 500–177–2), the cost for medical assessment of illnesses is too high (see, *e.g.,* 30–1026, 30–1302, 30–0295, 30–1362, 30–0070, 30–0262, 30–0586, 30–0280, 30–3760), and the proposed requirements are too prescriptive (Ex. 30–400, 30–1294, 500–177–2);
- The proposed provisions are unclear about what the employer is supposed to do (Ex. 30–3344), fails to tell an employer when to provide access to an HCP (Ex. 32–120–1), or uses vague terms (see, *e.g.,* Exs. 30–2987, 30–3364, 30–3677);
- The proposed provisions conflict with workers' compensation laws (see, *e.g.,* Exs. 30–300–1, 30–710, 30–1350, 30–1722, 30–2435, 30–2987, 30–3284, 30–3745, 30–3765, 30–3845, 30–4026, 30–4564, 30–3677, 30–4499, 31–172, 31–180, 31–220, 31–252, 32–206–1);
- The proposed provisions create a preferential system for MSDs and enforces the notion that ergonomics injuries are more important than other injuries (see, *e.g.,* Exs. 30–1294, 30–3765, 30–4470, 30–4843, 31–280, 500–177);
- The proposed provisions would interfere with existing collective bargaining agreements (see, *e.g.,* Exs. 30–3284, 30–3765, 32–266–1);
- The proposed provisions would address a problem that was, in the opinion of these commenters, largely or exclusively non-occupational in origin (see, *e.g.,* Exs. 30–240, 32–241–4, 30–3167, 30–3956, 30–3956, 30–4046, 30–4713, 32–241–4); and
- The proposed provisions change the traditional relationship between doctors, patients and employers (Exs. 30–4470) or inappropriately inject the employer into the employee-patient relationship (Ex. 30–4567).

In a representative comment, the Dow Chemical Company (Ex. 30–3765) stated that (1) a management system for work-related injuries already exists through workers' compensation laws, (2) the proposal may conflict with some collective bargaining agreements, and (3) a special work restriction protection is not warranted for MSDs because of their multifactorial nature. The Anheuser-Busch Companies, Inc. and United Parcel Service, Inc. added ''[t]he proposed rule is doomed to fail as a result of its exclusive focus on workplace activity'' *i.e.,* on the work-related rather than non-occupational causes of MSDs (Ex. 32–241–4, p. 182).

The proposed rule would have required employers to provide injured employees with prompt access to an HCP, *when necessary,* for evaluation, management and follow-up. OSHA has reconsidered the issue, and now believe that any MSD incident is serious enough to warrant MSD management.

Several commenters recommended that OSHA require an employer to refer an employee with complaints or signs or symptoms of an MSD to a HCP for evaluation, management, and follow-up immediately, rather than ''when necessary,'' as proposed (Exs. 30–651, 30–3826, 30–3686, 30–2387, 30–4468, 32–339–1, 32–111–4, 32–182–1, 30–4538, 32–210–2, 32–461–1, 32–85–3, 32–210–2, 32–450–1). For example, the United Food and Commercial Workers (UFCW) argued that having every worker assessed initially by an HCP would resolve many issues raised by the proposal, such as ''when to refer the employee to the HCP,'' ''follow-up,'' and ''deciding appropriate work restrictions'' (Ex. 32–210–2). The American Association of Occupational Health Nurses (AAOHN) (Ex. 30–2387) commented that ''[e]mployers should automatically be required to refer employees with MSD complaints to health care professionals for evaluation and determination about physical capabilities and work restrictions. Most employers are not qualified to make this determination.'' The AAOHN also stated that ''[d]ecisions related to signs and symptoms of MSD[s] and placement of temporary work restrictions should be made by a health care professional'' (Ex. 30–2387). Some commenters stated that the phrase ''when necessary'' was unclear, confusing, and vague (Exs. 30–2987, 30–3782, 30–3826, 30–3845). Other commenters, however, agreed with the ''when necessary'' language, on the grounds that it gave the employer the flexibility to decide when an employee needs to be referred to an HCP (see, *e.g.,* Exs. 30–3813, 30–4467, 32–300–1).

OSHA has deleted the ''when necessary'' language from the final rule. The final rule only applies to specific injuries (those with restrictions, medical treatment, or persistent signs and symptoms) and OSHA finds that these injuries should always be followed by medical management, including access to an HCP. This change clarifies the final rule and assures prompt medical management for employees who need it.

Several commenters recommended alternative approaches to MSD management. The Pinnacle West Capital Group suggested OSHA simply leave MSD management to the employers discretion (Ex. 30–3032). PPG Industries suggested that OSHA only require an employer to have in place a system that focuses on early intervention (Ex. 30–1294). Ashland Distribution Co recommended OSHA:

> [d]elete [the] last sentence of 1910.919 and [the] remainder of MSD management, and add ''You must make MSD management available promptly whenever a covered MSD occurs. You must provide MSD management at no cost to employees. A health care professional should be involved in MSD management when necessary'' (Ex. 30–4628) (see also Ex. 31–337).

In the final rule, OSHA has decided to carry forward the MSD management provisions of the proposed rule with only minor modifications. The MSD management provisions of the final rule emphasize the prevention of impairment and disability through prompt evaluation and management of MSD incidents, evaluation by a health care provider, provision of needed work restrictions, and appropriate follow-up. The provisions are included because successful ergonomics programs include MSD management, OSHA has had successful experience with including MSD management as part of an ergonomics program agreement with employers, and OSHA therefore believes that MSD management is essential to the proper functioning of an ergonomics program.

The MSD management provisions of the final rule are based on the many successful ergonomics programs that include policies for the medical management of MSDs, and the final rule contains provisions similar to those in such programs (see, *e.g.,* Exs. 26–2, 32–450–1). The MSD management provisions of the final standard are thus built on the processes that employers with effective ergonomics programs are using to help employees who have work-related MSDs.

MSD management is recognized by employers, HCPs, and occupational safety and health professionals as an essential element of an effective ergonomics program (see, *e.g.,* Exs. 26–1, 26–5, 26–1264, 32–450–1, 30–4468, 37–12, 37–28). Among employers who have told OSHA that they have an ergonomics program, most reported that their programs include MSD management as a key element (see, *e.g.,* Exs. 3–56; 3–59; 3–73; 3–95; 3–113; 3–118; 3–147; 3–175; 3–217; and Exs. 26–23 through 26–26, 500–71–84). This approach is also supported by the scientific literature concerning ergonomics as evidenced by the comments of Robin Herbert, MD (Ex. 37–28):

> The MSD [proposed] management provisions are consistent with approaches enumerated in a number of medical textbooks and peer-reviewed papers * * *. The MSD management section recommendations would be likely to diminish the severity of, and, consequently, the disability and suffering associated with, MSDs.

The final rule's MSD management provisions are also based on OSHA's experience with ergonomics over the last 15 years. For example, MSD management provisions were included in OSHA's 1990 Ergonomics Program Management Guidelines for Meatpacking Plants (Ex. 26–3). In addition, MSD management provisions have been included in all of OSHA's corporate settlement agreements addressing MSD hazards. In a 1999 workshop to discuss the experience of companies with corporate wide settlement agreements, the companies who were involved stated that ''[q]uality healthcare is a must'' for an ergonomics program, and ''[g]ood medical management allows early reports and reduces surgeries'' (Ex. 26–1420). Further, to become a member of OSHA's Voluntary Protection Program, employers are required to include ''Occupational Heath Care Program'' provisions in their safety and health programs that address MSDs and their management, along with other health hazards.

There are many reasons why MSD management is essential to the success of an ergonomics program. As mentioned above, MSD management emphasizes the prompt and effective evaluation and management of MSD incidents, with appropriate follow-up for the injured employee. When MSD incidents are managed effectively, they are more likely to be reversible, to resolve quickly, and not to result in disability or permanent damage. MSD management also helps to reduce the overall number of MSDs in a given establishment because it alerts employers to MSD hazards in their jobs so that they can take action before additional problems occur. An MSD management process that encourages early reporting and evaluation of that first MSD helps to ensure that the analysis and control of the job is accomplished before a second employee on that job develops an MSD. MSD management thus reduces MSDs through prevention. In addition, MSD management helps to prevent future problems through the development and communication of information about the occurrence of MSDs to employees.

Finally, where engineering, design and procurement personnel are alerted to the occurrence of MSDs, they can help to implement the best kinds of ergonomic controls: those that engineer out MSD hazards in the design and purchase phases and thus prevent MSD incidents from occurring.

The final rule does not require the employer to provide MSD management for all MSDs, but only requires MSD management for MSD incidents that occur to a worker in a job that exceeds the action trigger. This helps to assure that MSD management is only required for work-related MSDs, and that non-occupational MSD cases are excluded. The final rule does not require the employer to take any action for non-work-related MSD cases. The only obligation may be to determine the work-relatedness of an MSD report from an employee to make sure that the MSD is non-occupational, but no other action is required.

Requiring MSD management only for MSD incidents, as defined by the final rule, also makes sure that the MSD is a more serious case, and that MSD management, as well as the other elements of an ergonomics program, are not being required for cases that involve only minor pain or soreness but are being provided for disorders that need treatment and cases with persistent signs or symptoms. Requiring MSD management under these circumstances also makes sense because all of the program elements are initiated with the same implementing mechanism; requiring MSD management without the other elements of an ergonomics program would be inconsistent and ineffective.

The final rule requires MSD management for all MSD incidents when the worker's job exceeds the action trigger. OSHA has eliminated the phrase ''when necessary'' so the MSD management provisions apply to all MSD incidents. If an MSD has resulted in days away from work, restricted work, or medical treatment, and the employee's job exceed the action trigger, there is no further reason for delay. MSD management is clearly needed for these MSDs, and the final rule requires it. The final rule does not mandate MSD management for MSDs that do not rise to that level. For other incidents, the employer will have to make a decision about what MSD management actions are appropriate, but the final rule does not require them.

OSHA also believes that the final rule strikes the necessary balance between being too prescriptive and too vague. The provisions of OSHA's standard 29 CFR 1910.151 Medical services and first aid merely require the employer to ''ensure the ready availability of medical personnel for advice and consultation on matters of plant health'' and do not provide sufficient guidance for the effective management of MSD incidents. Likewise, simply leaving MSD management to the discretion of the employer, or including a simple reference to provide MSD management ''when necessary'' would not provide enough guidance for employers, health care professionals, or workers. At the same time, the final rule's provisions requiring employers to provide access to a health care professional, provide work restrictions, and generally evaluate, manage and follow-up on an MSD incident provide the flexibility needed for the variety of MSD cases that employers will encounter. An employee who has suffered a severe back injury from lifting a heavy object and is experiencing agonizing pain and an inability to function may need immediate treatment in an emergency room, while a worker who is experiencing a gradual worsening of pain in the wrists may require prompt (but not immediate) treatment by a specialist.

OSHA finds that the arguments that the rule changes the traditional relationship between doctors, patients and employers (Exs. 30–4470) or inappropriately injects the employer into the employee-doctor relationship (Ex. 30–4567) are without merit. Employers have, for many years, experienced a relationship with the medical community in regards to employees work and non-work related injuries and illnesses. Employees commonly obtain written notification from a physician to explain time off of work for personal illness. Employers frequently consult with a health care provider when an employee is injured or becomes ill at work, to determine appropriate time off, restrictions or medical treatment, and the requirements of the final rule are not much different. Employers also consult with health care professionals when they contest workers' compensation claims, during tort litigation, or when implementing reasonable accommodations for disabled persons as required by the Americans with Disabilities Act (ADA).

Finally, OSHA believes these requirements are needed to make sure that employees get the medical attention they need. As the Thermoquest Corporation stated:

> [i]f there are no clear guidelines, many employers may not allow an employee to seek medical help for various reasons. Also to leave it up to the employee when to see a physician allow for employee abuses. The difficulty lies in getting the injured employee the treatment they need in a timely manner (Ex. 31–301).

OSHA's responses to the comments that the MSD management provisions exceed OSHA's legal authority, affect workers' compensation, or impact collective bargaining agreements are addressed in the section of this preamble dealing with worker removal protection.

Who Provides MSD Management Services?

The preamble to the proposed rule explained that the proposed ergonomics rule would have permitted ''persons in the workplace and/or HCPs'' to provide injured employees with evaluation, management, and follow-up in connection with the MSD management process (64 FR 65838). The regulatory text required that an employer provide access to a health care professional for evaluation, management and follow-up ''when necessary'' (64 FR 66073).

Many commenters (see, *e.g.,* Exs. 30–3826, 30–2387, 32–450–1, 32–210–2, 30–2806, 30–4468) argued that the inclusion of individuals without medical training and experience in the MSD management process was inappropriate. For example, the American Association of Occupational Health Nurses (AAOHN) strongly disagreed with the proposal's use of the phrase ''or other safety and health professionals as appropriate'' in the MSD management process on the grounds that assessing, providing prompt management/treatment to, and following-up individuals with medical problems are clearly activities within the scope of health care professionals' professional licenses but are not included in the scope of practice of other safety and health professionals. The AAOHN stated that ''[i]t is imperative that the standard not enable non-licensed individuals to make health assessments and provide health care services without a professional license'' (Ex. 30–2387).

The National Institute for Occupational Safety and Health (NIOSH) noted that, although the institute supports ''[e]mployers' efforts to train employees in the early signs and symptoms of MSDs and to seek HCP evaluation when appropriate,'' it ''recommend[s] that the standard preclude non-HCPs and non-licensed HCPs from conducting medical evaluations.'' In addition, NIOSH noted that, the institute ''[s]upports OSHA's proposal that permits the MSD management programs to be administered by a variety of licensed HCPs as defined (in the proposal's definition section). However, [it] recommend[s] that the clinical aspects of the program (medical evaluations of symptomatic workers) be performed by licensed HCPs under the supervision of HCPs licensed for independent practice (including physicians, and nurse practitioners and physicians' assistants in those states where they are so licensed)'' (Ex. 32–450–1). Other commenters (see, *e.g.,* Exs. 30–3826, 32–210–2, 30–4468, 30–2806) agreed that evaluating an employee's complaint of an MSD or assessing the physical capabilities of the employee to return to work or his or her need to rest the injured part may require expertise that an employer or other safety and health professional does not have.

The American College of Occupational and Environmental Medicine (ACOEM) noted that ''[i]f MSD signs are to be included as part of the triggering event, the employee must be examined by a physician with training in medical diagnosis'' (Ex. 30–4468). The ACOEM expressed concern that ''flexibility'' in allowing non-HCPs to evaluate employee reports of signs and symptoms ''[w]ould result in employers—who are not likely qualified—making assessments or diagnoses. * * * Therefore, ACOEM recommends that the determination of a recordable MSD be made by a qualified occupational healthcare professional'' (Ex. 30–4468).

The United Food and Commercial Workers (UFCW) agreed that HCPs, rather than others, should conduct MSD management, arguing that the OSHA proposal failed to require that an HCP make the initial assessment of the worker's condition, a crucial element of MSD management in the union's view. UFCW stated that ''[a]ll successful programs that we have experience with have this core element'' (Ex. 32–210–2). The UFCW emphasized this point by stating that, in corporate wide settlement agreements (CWSAs) between companies and OSHA, ''OSHA and the industry recognized that lay persons were not capable of assessing symptomatic employees'' (Ex. 32–210–2). Arguing along similar lines, the American Association of Orthopaedic Surgeons (AAOS) commented that ''[i]t is inappropriate to ask the employee and employer to diagnose the employee's problem and determine if it is or is not related to work and deserving of further attention from the employer'' (Ex. 30–2806). In her testimony, Mary Foley, President of the American Nurses Association (ANA), strongly encouraged:

> OSHA to require that employers place the responsibility for evaluating MSDs with the licensed healthcare providers. Evaluating signs and symptoms and determining whether an injury has occurred is the responsibility and within the scope of practice of licensed health care providers. The supervisor and worker relationship is not a relationship that should involve or appropriately involves diagnosing physical injuries. If the employer erroneously decides that a covered MSD has not occurred, continuing to perform the hazardous job would result in a delay in evaluation and treatment, and could intensify the injury or seriously compromise the recovery, permitting managers and supervisors to assume these activities, place the employer and/or manager at risk of litigation for practicing medicine without a license or for denying medical attention to an injured person (DC 5/8/2000, Tr. 15884).

The final rule requires the employer to provide MSD management to employees who have suffered an MSD incident, if they are employed in a job that rises to the level of the action trigger, including prompt access to an HCP. OSHA agrees with these commenters that non HCPs should not provide medical services appropriately reserved to a health care professional. The final rule does not allow a non-HCP to provide medical services, and it was never OSHA's intent in the proposal to allow a non-HCP to provide medical services that are only appropriate to an HCP. Oftentimes, an HCP will have been involved in the MSD case well before the final rule requires MSD management, while the employer is determining the work-relatedness of the MSD case, and because the MSD incident, by definition, must involve days away from work, restricted work, medical treatment, or persistent signs/symptoms before it is covered by the MSD management provisions.

However, there are circumstances where an employer may provide a worker with work restrictions before consultation with an HCP. In some cases, the restrictions may be obvious. For example, if an employee injures his or her back, limiting the lifting the employee is required to perform is a logical action to take. In other instances, the employer may have had experience with similar MSD cases in the past, and the types of restrictions that are needed are familiar to the employer. In the situation where the employer knows what restrictions may be necessary, the final rule requires the employer to provide such restrictions. Providing restrictions even before consultation with an HCP can provide relief to the employee, reduce the severity of the case, and begin the healing processes at an earlier stage.

The Definition of Health Care Professional

The final rule and the proposal define health care professionals as ''physicians or other licensed health care professionals whose legally permitted scope of practice (*e.g.* license, registration, or certification) allows them to independently provide or be delegated the responsibility to provide some or all of the MSD management requirements of this standard.''

Several commenters supported the proposed definition of ''HCP'' (see, *e.g.,* Exs. 3–73, 30–519, 30–2387, 30–2807, 30–3745, 30–3748, 30–3813, 30–4567, 30–4844, 32–85–3, IL–182). For example, the Rural/Metro Corporation (Ex. 30–519) stated that the definition of HCP in the proposal was appropriate because OSHA should not attempt to decide scopes of practice for HCPs. The AAOHN (Ex. 30–2387) stressed that a ''[k]nowledgeable health care professional, practicing within their legal scope of practice, establishes procedures, or consults with the employer in the establishment of procedures, to determine what is to be done when an employee reports a MSD or persistent MSD symptoms.'' In her testimony for the AAOHN, Sandy Winzeler stated:

> It is appropriate for OSHA to recognize the roles that different health and safety disciplines play in health and safety programs. * * * Each discipline has a unique contribution to make to the program; in this case, the prevention and management of MSDs. It is only through such collaboration that we are successful. However, it is inappropriate for OSHA to include language in a standard that would restrict the practice of any health care professional. As you are aware, health care professionals are regulated by the States. The current language used in the proposal defers to State law in determining whether the individual can fulfill the requirements under their licensed scope of practice, and AAOHN supports this. Over half of the States permit nurse practitioners to practice independently without any requirement for physician supervision or collaboration. This includes the ability to make independent medical diagnosis. Registered nurses often work in collaborative arrangements with physicians especially in the occupational health setting. It is impractical to expect that a physician will be on site and available to evaluate every employee, and in fact, it is usually the occupational health nurse that is on the front line, at the work site, working with employees every day. OSHA should recognize the important role that nurses play and by no means should limit our ability to fully practice within our legally defined scope [DC 3/29/2000, Tr. 5588–5590].

The American Physical Therapy Association (APTA) also expressed support for ''OSHA's recognition of licensed nonphysician providers'' and noted that ''[o]ther Federal programs, such as Medicare, defer to the states to determine licensure and scope of practice of the providers that participate in the program'' [30–3748].

Other commenters urged OSHA not to limit employers' choice of HCPs to specialists, who are often not available in reasonable proximity, which would delay prompt evaluation, management, and follow-up and make it much more costly (Ex. 3–73, 36–1370, 30–3745, IL–182). For example, the American Feed Industry Association, whose members have facilities in rural areas, expressed concern that the medical profession in a rural area may not have the expertise to deal with work-related MSDs, and pointed out that compliance could be a problem if the standard stipulated that the HCP have a specific background (Ex. 3–73, 30–3745, IL–182).

Other commenters opposed the proposed definition (see, *e.g.,* Exs. 30–494, 30–991, 30–2208, 30–3004, 30–2208, 30–2676, 30–4468, 30–4699, 30–3749, 30–3783, 30–3781, 30–3937, 30–4025, 30–4467, 30–4538, 30–4843, 32–22–1, 32–339–1, 32–111–4, 32–182–1, 32–210–2, 32–300–1, 32–461–1). Many of these commenters held the opinion that the definition was too broad (see, *e.g.,* Exs. 30–991, 30–2208, 30–3004, 30–2208, 30–4468, 30–4699, 30–3749, 30–3783, 30–3781, 30–3937, 30–4025, 30–4467, 30–4538, 30–4843, 32–22, 32–339–1, 32–111–4, 32–182–1, 32–210–2, 32–300–1, 32–461–1). The comments of the Combe Inc. company are representative: ''[b]y allowing persons who do not even have a medical degree to diagnose and treat these disorders, the proposed standard creates an environment where the potential for misdiagnosis and improper treatment efforts is dramatically increased'' [Exhibit 30–3004]. The Center for Office Technology pointed out that because the definition is so broad, it could include occupations such as emergency medical technicians or licensed vocational nurses who would not be the appropriate professionals to make decisions with respect to MSDs [Ex. 30–2208]. The New Mexico Workers' Compensation Administration argued that a massage therapist could render an opinion on MSDs (Ex. 32–22).

A number of commenters recommended OSHA limit HCPs to physicians, nurse practitioners, or physician's assistants (see, *e.g.,* Exs. 32–339–1, 32–111–4, 32–182–1, 30–4538, 32–210–2, 30–4468, 30–4699, 32–450–1, 30–2806, 32–300–1). Others advised that HCPs be limited only to physicians [Exhibit 30–351, 30–3749, 30–3344]. Several commenters acknowledged OSHA's attempt to reduce the cost of the standard, but noted that fact finders rely heavily upon treating physician's opinions when litigating causation issues under the various worker's compensation laws (Exs. 30–3749, 30–3344, 30–4674).

Other commenters argued that the ergonomics rule should require HCPs to have specific training (see, *e.g.,* Exs. 30–626, 30–3032, 30–4467, 30–4538, 32–339–1, 30–4468, 30–2806, 30–3934, 30–3745, 30–3937, 32–300–1). For example, the law firm of Morgan, Lewis and Bockius argued that HCP's not specifically trained in musculoskeletal disorders would not be able to make accurate diagnoses and that HCPs without MSD specific training ''[m]ight actually irritate conditions or prescribe incorrect treatments, or impose unwarranted obligations on employers' (Ex. 30–4467). The International Association of Drilling Contractors (Ex. 30–2676) commented that ''According to a recent medical publication, 82% of medical school graduates failed a valid musculoskeletal competency examination. (The Journal of Bone and Joint Surgery, Vol. 80–1, No. 10, October 1998, pp. 1421–1427)'' to argue that ''This startling statistic makes one question how a general physician may properly diagnose a MSD'' and the ''[i]nclusion of other fields under its [OSHA's] definition of HCP is all the more unacceptable''. However, the International Association of Drilling Contractors did not submit a copy of the article into the rulemaking docket, so OSHA is not able to fully evaluate the journal article. It appears to be a competency examination for a specialized medical field, and it is unclear that the examination uses the same definition of musculoskeletal disorder as OSHA's rule, so OSHA does not believe that the article provides evidence contrary to the final rule's definition of HCP.

Several commenters encouraged OSHA to define the specific competencies an HCP should acquire to be qualified to screen, diagnose and manage MSD cases (see, *e.g.,* Exs. 30–2806, 32–182–1, 32–300–1). For example, the American Association of Orthopaedic Surgeons (Ex. 30–2806) found OSHA's proposed definition to be incomplete, and suggested the ergonomics rule include a requirement to use HCPs who are ''[h]ighly trained and qualified'' and who are ''[k]nowledgeable in the assessment and treatment of MSDs'' to ensure appropriate evaluation, management and follow-up of workers' MSDs.

The American College of Occupational and Environmental Medicine (ACOEM) recommended the definition of health care professional be changed to ''*occupational* physicians or other licensed *occupational* health care professionals'', focusing on the HCP's training and competencies in occupational medicine. ACOEM recognized the important role of non-physicians such as nurses, physician's assistants, and other health care providers, but argued that the healthcare provider must be able to perform four basic functions to perform the duties of an HCP required by the proposed ergonomics standard:

(1) Make independent diagnoses (which is usually limited to physicians, except in those states where nurse practitioners and physician assistants are licensed for independent practice);

(2) Conduct an appropriate physical exam,

(3) Order appropriate treatment, and

(4) Be able to relate musculoskeletal findings to work activities (which requires an understanding of basic epidemiology).

ACOEM further argued that OSHA's definition was questionable because other federal agencies have refused to adopt OSHA's definition of a ''licensed health care professional'' used in other standards. AECOM cites as examples, a NIOSH policy statement on respirator use, as well as the Department of Energy (DOE) rule on Beryllium. AECOM also cited the variability of state health care licensing laws as a reason for restricting the definition, and that state scope of practice laws were ''never intended to be the mechanism to protect a worker from a toxic, carcinogenic, or biological exposure in the workplace'' [Exhibit 30: 4699].

The National Institute for Occupational Safety and Health (NIOSH)

> [s]upports OSHA's proposal that permits MSD management programs to be administered by a variety of licenced HCPs * * * However, we recommend that the clinical aspects of the program (medical evaluations of symptomatic workers) be performed by licensed HCPs under the supervision of HCPs licensed for independent practice (including physicians, and nurse practitioners and physician's assistants in those states where they are so licensed) (Exhibit 32–450–1).

In the final rule, OSHA has carried forward the definition from the proposed rule:

> Physicians or other licensed health care professionals whose legally permitted scope of practice (e.g. license, registration or certification) allows them to independently provide or be delegated the responsibility to provide some or all of the MSD management requirements of this standard.

The final rule's definition of HCP is desirable for several reasons. Perhaps most important is that the HCP definition provides employers with the flexibility needed to assure that injured employees receive ''prompt and effective'' MSD management. Specialists and occupational physicians are not always readily available, and the rule allows the employer to consult health care professionals with these qualifications when needed, but does not require the employer to seek them out for each and every case. In some rural locations, access to specialized HCP's may be limited, and even in more urban settings, it may take significant time to get an appointment for an employee to see a specialist. If the employee can see a physician in general practice promptly, this may be the better option. Likewise, if an employer has an occupational health nurse, the nurse can provide services immediately and avoid delay.

Each MSD case also requires its own level of occupational health services. In some cases, a registered nurse or physician's assistant may be able to recommend restrictions and conservative treatment and resolve the problem. In other cases, the services of a physician or a medical specialist may be needed to treat the employee. The final rule does not restrict the employer's option to obtain more specialized services, and it is a common practice for HCPs to refer cases needing more specialized care to more qualified HCPs. OSHA sees no reason why this system will not continue to function as well as it has in the past.

The HCP definition is consistent with many of OSHA's health standards. In its most recent health standards (*e.g.,* respiratory protection, methylene chloride, proposed tuberculosis rule) the Agency has relied on a broad definition of HCP, to allow HCPs to carry out any of the regulatory requirements specified in a given standard, provided that the medical function performed is within their scope of practice, licensure, or certification. OSHA has not noted any significant problems with the definition in employers implementation of these standards, the definition appears to be working as intended, and OSHA's broad definition of HCP published in the respiratory protection standard has been upheld in the courts (American Iron and Steel Institute v. OSHA, 182 F.3d 1261 (11th Cir. 1999)). In addition, consistency from standard to standard is a desirable feature that makes it easier for employers and workers to understand and follow the standards.

The definition also relies on the licensing requirements imposed by the states. As stated in the proposal (FR 65842), OSHA believes that issues of HCP qualifications and scope of practice are properly addressed by State law and professional organizations. The states have been regulating medical practice for quite some time, and appear to be doing so effectively, so there is no reason to interfere with the licensing procedures the states have implemented. Relying on the state requirements will assure that unqualified or inappropriate individuals do not provide medical services beyond their training and qualifications, and the state licensing boards can continue to handle cases where improper treatment is provided or improper actions are taken.

The final standard does not contain diagnostic or treatment protocols. OSHA believes this is an area for the health care professions to recommend. Also, because standards of care change over time, it is the responsibility of the treating health care professional to select treatments in accordance with current acceptable standards of practice. NIOSH supports OSHA's ''[d]ecision not to include particular diagnostic tests, treatment protocols, and clinical case definitions in the MSD management section, or anywhere else in the ergonomic standard. Standards of care change over time, evolving with new research, technological innovations, and new therapies. To allow workers to be provided with current, state-of-the-art clinical care, OSHA is correct to leave diagnostic and therapeutic decisions to HCPs and their professional organizations'' [Ex. 32–450–1].

Who Selects the Health Care Professional

Some commenters raised the question of whether the employer or the employee get to choose the health care professional providing services. The American Apparel Manufacturing Association remarked

> OSHA has also failed to address the issue of choosing doctors. In some states, patients have the right to choose their own physicians. In other states, employers choose the doctors. Does the employer choose the HCP under the proposed federal rule, or could employees choose a doctor who will diagnose an MSD without real cause and expose companies to possible fraudulent actions? Does the proposed law supercede state laws in those states where the patient may choose? (Ex. 30–4470)

Several commenters recommended that OSHA specify in the standard that the employer has the right to choose the physician (see, *e.g.* Exs. 30–3188, 30–3284, 30–4301, 30–4467, 30–4564, 30–4607, 32–300–1, 32–337–1) In a representative comment, Southern California Edison argued that:

> Since the employer is required to follow the HCP's advice, the employer must be able to trust the diagnosis. However, not all healthcare providers are qualified by training or experience to evaluate, treat and provide restrictions for musculoskeletal disorders. If the employee is permitted to select the healthcare provider, as they are allowed by some states' workers' compensation laws, they may not select the provider that will have the time or experience to work with the company in determining appropriate restrictions (Ex. 30–3284).

Another group of commenters recommended the opposite, that the employee should be allowed to select the physician (see, *e.g.* Exs. 30–3033, 30–3034, 30–3035, 30–3258, 30–3259, 30–4159, 30–4536, 30–4547, 30–4549, 30–4562, 30–4627, 30–4776, 30–4800, 31–242). A form letter submitted by a number of individual employees made several arguments, including ''[t]he HCP must be one of the employee's choosing, not the employer's (or insurance company's) choosing. Otherwise, a biased opinion may result, and the employee's condition can easily worsen''; that general practitioners ''are often the HCPs that are chosen by the employer or insurance company to diagnose work-related injuries under the Workers' comp system. It is common to underestimate the seriousness and long term consequences of MSD injuries, and consequently, not enough temporary work restrictions are recommended''; and ''HCPs chosen by someone other than the employee may be biased in favor of the employer or insurance company in order to obtain future referrals'' (Ex. 30–3332).

The comments from both employers and employees show a large measure of distrust for health care professionals selected by either. It is for this reason that the final rule includes provisions for multiple HCP review. It is OSHA's view that, when the employer provides access to an HCP under the final rule, the employer has the right to select the HCP. However, the employee has a right to a second opinion if he or she disagrees with the employer selected HCP, under the provisions of paragraph (s). A more detailed discussion of HCP selection is contained in the discussion of multiple HCP review.

''Prompt'' MSD Management

The proposal would have required employers to respond promptly to the reports of employees with MSDs, and the final rule includes similar language. Whenever an employee reports an MSD, the key is to take action quickly to help ensure that the MSD does not worsen. Many commenters agreed that early reporting and prompt response were the key to resolving MSD problems quickly and without permanent damage or disability [Exs. 30–4468, 32–78–1, 32–85–3, Tr., p 10516). For example, the American College of Occupational and Environmental Medicine (ACOEM) remarked that ''[e]mployers should ensure that injured employees are provided with 'prompt access to health care professionals or other safety and health professionals as appropriate.' The early reporting and intervention process is important to the effectiveness of a medical management program'' (Ex. 30–4468). Other commenters argued that the first response to any report of MSD should be evaluation by a health care professional (Exs. 30–651, 30–3826, 30–3686, 30–2387, 30–3748, 30–4468, 32–339–1, 32–111–4, 32–182–1, 30–4538, 32–210–2, 32–461–1, 32–85–3, 32–210–2, 32–450–1).

Some commenters stated that ''promptly'' was vague and ill defined, questioning what the term ''promptly'' meant in the provision directing employers to respond to employee reports (see, *e.g.* Exs. 30–115, 30–2208, 30–33336, 30–3354, 30–3845, 30–3848, 30–4540). Bruce Cunha RN MS COHN-S (Ex. 31–303) stated that ''Five days should be adequate time to start the management process. If it is enough time to arrange a visit with a health care professional is questionable. Since OSHA allows the employer to choose the health care provider, it should be expected that it may take longer than 5 days to get an appointment.''

The final rule requires the employer to provide ''prompt'' MSD management. The term ''prompt,'' as used in this paragraph, means as soon as possible or within a reasonable period of time, consistent with the apparent severity of the MSD or with other conditions (*e.g.,* accessibility of medical care). OSHA believes, as the proposal discussed, that employers will almost always be able to provide MSD management within a one to five day window (64 FR 65840). Action within this interval will generally prevent the employee's condition from becoming more severe.

In the final rule, OSHA has provided clear guidance that prompt is one week. Paragraph (x), Table 2. Compliance Time Frames states that MSD management must be initiated within 7 calendar days after the employer determines that a job where an employee experiences an MSD incident meets the action trigger. OSHA finds that one week is more than enough time to initiate MSD management, select an HCP, and set an appointment for the employee to see an HCP.

In some workplaces, an occupational health nurse is available to take reports of MSDs, and in this case MSD management begins immediately, so promptness is not an issue. In most cases, however, employers will not have an on-site HCP, since smaller workplaces make up the overwhelming majority of all workplaces. In such cases, OSHA is aware that it may take a few days to arrange an appointment with an HCP. There are circumstances, however, where immediate evaluation by an HCP is warranted. For example, an employee experiencing severe shoulder pain with numbness down her arm, an inability to sleep due to pain, and decreased range of motion of the arm and shoulder should immediately be referred to an HCP.

Prompt MSD management helps limit further exposure to the MSD hazard or hazards associated with the employee's job helps to ensure that the employee's condition does not worsen while the employer analyzes the problem job and makes workplace changes to correct the hazard.

Providing MSD Management at no Cost to Employees

Both the proposed rule and the final rule require the employer to provide MSD management at ''no cost to employees.'' The requirement to provide MSD management at no cost drew little comment. Some commenters supported the no cost clause (see, *e.g.,* Exs 30–4536, 30–4547, 30–4549, 30–4562, 32–78–1). Vicorp Restaurants asked OSHA if the employer is required to pay even if the report is ultimately determined to be frivolous, exaggerated, or fraudulent (Ex. 30–3200). Other commenters argued that the cost for medical assessment of illnesses is too high (see, *e.g.,* 30–1026, 30–1302, 30–0295, 30–1362, 30–0070, 30–0262, 30–0586, 30–0280, 30–3760). A few commenters suggested that OSHA clarify that ''at no cost'' doesn't include loss from production based pay and bonuses (Ex 30–3354, 30–3848, 30–4530, 30–4799).

As OSHA explained in the preamble (64 FR 65841) the term ''at no cost to employees'' includes making MSD management available at a reasonable time and place for employees (*i.e.* during working hours) and that the term no cost is interpreted in the same way as OSHA's other health standards. If an employee's MSD report is found to be fraudulent, then the employer is not required to pay for MSD management. A fraudulent claim would be one that is found to be non-work-related, and MSD management is only required for work-related MSD incidents. These wages would not include production bonuses or other premium payments, but for workers who are paid on a piecemeal basis, the employer must assure that the employee would not lose pay by visiting an HCP. This can easily be accomplished by paying the worker the average piecemeal rate he or she had been earning.

OSHA recognizes that MSD management imposes costs on employers, and these costs are reflected in the economic analyses for the final rule. However, if employees were made to absorb the costs of MSD management, they would be less likely to report MSDs to their employer, which would have a detrimental effect on the overall functioning of the rule.

Follow-up

The final rule, as did the proposal, requires that the employee receive appropriate follow-up during the recovery period. Follow-up is defined as the process or protocol the employer, safety and health professional, or HCP uses to check up on the condition of employees with covered MSDs when they are given temporary work restrictions or removed from work to recover.

OSHA received very little comment specific to follow-up. The Southern California Edison company stated that the proposed rule:

> [p]laces the responsibility on the employer to ensure that the employee goes to the HCP initially and as required thereafter. This assumes a cooperative employee. The final standard should make clear that an employer could not be cited because an employee refuses to see the HCP (Ex. 30–3284).

OSHA has included the requirement for follow-up in the final rule. Follow-up of injured employees is essential to ensure that MSDs are resolving. Follow-up generally means additional visits to the HCP to see if the employee is getting better or is getting worse. This process helps to ensure that injured employees do not ''slip through the cracks,'' for example, by being left in alternative duty jobs long after they have recovered, or by being given work restrictions but failing to follow up to see whether the restrictions helped. If follow-up is not provided, neither the employer nor the HCP will know whether an employee's MSD symptoms are abating or becoming worse. Where follow-up is not provided or the healing process is not properly monitored, injured employees may never be able to return to their jobs.

The employer need not be fearful of citation if the only reason follow-up is not completed is because the employee refuses to see an HCP. The employer is required to provide access to an HCP, but is not required to force an employee who does not wish to see the HCP to do so.

Medical Treatment

During the course of reviewing the comments to the proposed ergonomics standard, OSHA has noticed that some commenters believed that the proposed rule would require the employer to provide medical treatment as part of its MSD management provisions (see, *e.g.,* Exs 30–564, 30–1251, 30–2425, 31–353). Roy Gibson (Ex. 30–2526) remarked that ''Once employees are aware that medical treatment is an option open to them, they will request treatment.'' Allfirst Bank (Ex. 30–1251) asked ''How can we assure 'effective' treatment?''

OSHA wants to make it clear that the final rule does not require the employer to provide medical treatment to injured employees. While specific medical treatment may be appropriate, such as medicines, physical therapy, chiropractic care, or even surgery, the final rule does not require the employer to provide such services. The rule requires the employer to provide access to an HCP, provide needed restrictions, provide information to HCP's and employees, and provide WRP, but the standard does not address the medical treatment afforded employees. Therefore, if an injured employee needs medical treatment, the employer is not required to pay for them.

Temporary Work Restrictions

The final rule, like the proposal, requires the employer to provide temporary work restrictions, where necessary, to employees with MSDs. Work restrictions include any limitation placed on the manner in which an injured employee performs a job during the recovery period, up to and including complete removal from work.

Many commenters supported the requirement of providing temporary work restrictions, when necessary (see, *e.g.,* Exs. 30–3686, 30–3813, 32–339–1, 32–111–4, 32–185–3–1, 32–182–1, 30–4538, 31–353, 32–461–1, 32–198–4, 32–450–1, 37–12). NIOSH described the role of work restrictions as the first line of defense in addressing MSDs (Ex. 32–450–1) and that ''[c]ompanies should be able to continue the practice of placing symptomatic workers in temporary positions until a prompt evaluation by an HCP can be performed * * * '' (Ex. 32–450–1). Dr. Robert Harrison stated that:

Data from several studies suggest that job modification is significantly associated with improvement in clinical outcome. These studies have been summarized in a critical appraisal of the effectiveness of modified work programs (Krause 1998). This comprehensive review found that modified work programs facilitate return to work for temporarily and permanently disable workers. Employees with access to modified work return to work after a disabling injury about twice as often as employees without access to any form of modified duty . . . The findings from these studies conclusively show that early intervention and case management, including modified/restricted duty, will help prevent prolonged disability (Ex. 37–12).

However, some commenters argued against restrictions and recommended deleting the work restriction and work restriction protection provisions from the final rule (see, *e.g.,* Exs. 30–1294, 30–3765, 30–3813, 30–3956, 30–3845, 32–300–1). For example, the Edison Electric Institute argued that providing work restrictions

[m]ay conflict with existing collective bargaining agreements and current or future company philosophies on accommodating employees on restricted duty when there is no work available which they can perform under the indicated restrictions. This is especially true given the current climate of mergers, divestitures and competition in the electric utility industry (Ex. 32–300–1).

Other commenters asked what an employer is to do if there is no alternative work at the establishment (Exs. 30–2208, 30–3826) or no productive work (Ex. 30–240) available for the employee with the MSD. The Department of Defense stated that it may not be possible to provide work within an employee's work restrictions at some federal agencies (Ex. 30–3826).

A number of commenters stated that it was inappropriate for an employer to determine if an employee needs work restrictions before the employee is seen by a HCP (see, *e.g.,* Exs. 30–3033, 30–3034, 30–3035, 30–3185, 30–3188, 30–3258, 30–3259, 30–3284, 30–3765, 30–4046, 30–4159, 30–4536, 30–4547, 30–4549, 30–4562, 30–4607, 30–4647, 30–4713, 30–4776, 30–4800, 32–300–1, 500–163). For example, IBP Inc. argued that ''[a]s a rule, [they] are unable to determine an appropriate work restriction until the medical evaluation is completed. As a result, it is impossible to advise the HCP of available work restrictions'' (Ex. 30–4046). The Edison Electric Institute (EEI) argued that:

An HCP is better qualified to make an initial determination of an employee's physical limitations (*i.e.,* lift no more than 10 pounds, do not stand for more than 4 hours, etc.). The employer then is best qualified to determine appropriate work restrictions taking into account the physical limitations described by the HCP. OSHA provides no valid reason to complicate the process by having the HCP make the choice of work restrictions.

EEI recommends that § 1910.931(b) be deleted. Additionally, the phrase ''temporary work restrictions'' should be replaced with ''physical limitations'' in § 1910.932(b). This would then require only that the HCP provide a written recommendation of physical limitations. Additionally, the wording of § 1910.933(a) should be changed to reflect that the employer must take the HCP's physical limitations information and select the proper temporary work restriction that best addresses the limitations (Ex.32–300–1).

The Organization Resource Counselors suggested that there may be circumstances where the HCP makes errors and recommends inappropriate restrictions, suggesting OSHA add the phrase ''[e]xcept when you determine those recommendations to be clearly erroneous based on review of the written opinion by a physician or other HCP with specific training and experience in diagnosing and managing MSDs'' (Ex. 30–3813).

The United Mine Workers of America (UMWA) commented that complete removal from the workplace ''is an unacceptable response to the problem'' and that by including this in the definition of work restriction OSHA ''[h]as tacitly authorized the termination of employees who suffer from MSDs.'' The UMA goes on to recommend that all such language be deleted from the standard (Ex. 500–71–86).

However, under the final rule, the employer must provide restrictions deemed to be necessary by either the employer or the health care professional. Both the employer and the employee whose work has been restricted need to understand (1) what jobs or tasks the employee can perform during the recovery period, (2) whether the employee is permitted to perform these jobs or tasks for the entire workshift, and/or (3) whether the employee needs to be removed from work entirely in order to recuperate. Employees for whom restrictions have been assigned must be properly matched with those jobs that involve work activities that will accommodate the requirements of the restriction and thus facilitate healing of the injured tissue.

If an HCP recommends restricted work, employers must follow such restrictions. Thus, in those instances where the employer refers the employee to an HCP, the employer has to follow the temporary work restriction recommendations, if any, included in the HCP's opinion. If the employer receives a restricted work recommendation they believe to be inappropriate, the employer may refer the employee to an HCP with specialized training for further evaluation, but until the employer receives a new recommendation for restrictions, the employer must follow the recommendation of the first HCP. The provision of work restrictions to injured employees is a vital component of MSD management. Work restrictions provide necessary time for the injured tissues to recover. They are often considered one of the most effective means of resolving MSDs, especially if restrictions are provided at the earliest possible stage. If work restrictions are not provided, it may not be possible for the employee to recover, and permanent damage or disability may result.

For work restrictions to be effective, employers must ensure that they fit the functional needs of the injured employee. For example, work restrictions are only effective if they reduce or eliminate the employee's exposure to the workplace risk factors that caused or contributed to the MSD, or significantly aggravated a pre-existing MSD. To find the right fit, employers may need to examine potential alternative duty jobs to ensure that the employee will still be able to rest the affected area while performing the temporary job. Identifying appropriate work restrictions may require the collaboration of different persons such as HCPs, safety and health personnel, persons involved in managing the ergonomics program, and the injured employee.

The final rule's use of the term ''work restrictions'' includes both restrictions that keep the employee at work, such as half-days or job modifications, as well as full days away from work. This is in contrast to OSHA's recordkeeping rule, which defines restricted work separately from days away from work. Several of the commenters failed to recognize this important definitional aspect of the proposal. Because days away from work are included, the employer is not required to invent restricted duty assignments that keep the employee at work. If the employer does not have restricted work available, restricted work conflicts with collective bargaining agreements, or the employer simply wishes to do so, the employer may use days away from work to meet the requirement to provide restricted work. Of course, if the employee is sent home, he or she must provide WRP benefits as required by paragraph (r) of the final rule.

Although some covered MSDs could be at such an advanced stage that days away from work are the appropriate treatment, such removal is usually the recommendation of last resort. A recent study (Ex. 600–) suggests that removal from the workplace is assigned by HCPs in only about three percent of all MSD cases. Where appropriate, work restrictions that allow the employee to continue working (*e.g.,* in an alternative job, or by modifying certain tasks in the employee's job to enable the employee to remain in that job) are preferable during the recovery period. These types of restrictions allow employees to remain within the work environment. Studies indicate that the longer employees are off work, the less likely they are to return (Exs. 26–685, 26–919, 26–923, 26–924). A case study of a nursing home's early return to work program ''saved approximately $1 million in financial losses and improved injured workers' morale'' (Ex. 502–486).

If employers provide the HCP with accurate and detailed information about the employees job and, at a minimum, informs the HCP that the employer is willing to accept the employer back into the workplace with job restrictions, it is more likely that the HCP will recommend restricted activity at work rather than complete removal. Employers need to communicate with HCPs and supervisors to coordinate the provision of work restrictions.

Under this provision, employers are not required to provide the employee with the alternative job or work restrictions simply because the employee requests them. Therefore, if an HCP recommends that the employee not perform lifting tasks or not engage in repetitive motions during the recovery period, the employer is free to provide any form of work restriction that effectuates that work restriction recommendation. For example, if the recommended work restriction requires fewer repetitive motions, the employer can move the employee to an alternative duty job as a way of achieving this restriction. Or the employer might reduce the number of repetitions expected to be performed in the employee's current job in a number of ways: by reducing the amount of time the employee performs repetitive motions, by reducing the speed at which the employee performs the tasks, or by eliminating certain repetitive tasks during recovery. In the case of lifting jobs, the work restriction can be as simple as limiting the types or weights of objects the employee must move or lift.

The OSH Act prohibits employers from terminating an employee for reporting an MSD (or any injury or illness). OSHA does not condone the inappropriate termination of any employee for reporting an MSD (or any other injury or illness). ''Complete removal from the workplace'' simply denotes the provision of time completely off of work (days away from work) to allow the employee to recuperate from the MSD. Of course, some employees may become completely disabled and have to terminate employment. OSHA believes that these cases are fairly infrequent, and the ergonomics programs required by final rule should make them even more so.

Written Opinion From the HCP

The final rule, as did the proposal, requires the employer to obtain a written opinion from the HCP and provide a copy to the employee. This paragraph also instructs the employer that he or she must inform the HCP that the written opinion is not to contain any medical information not related to workplace exposure to risk factors, and that the HCP may not communicate such information to the employer, except when authorized by state or federal law. Paragraph (q) discussed below, then instructs the employer as to the specific items the written opinion must contain.

This section of the proposal received very little comment. A few commenters supported the written opinion requirement (Ex. 30–3813, 30–3686). The American Nurses Association supported the proposed requirement for a written opinion, remarking that ''The PLHCP should inform the employee and the employer, in writing, of the results of the evaluation, temporary work restrictions and medical conditions resulting from exposure to ergonomic hazards'' (Ex. 30–3686).

Other commenters objected to the requirement for an employer to obtain a written opinion (see, *e.g.,* Exs. 30–1070, 30–3231, 30–3336, 30–3347, 30–3392, 30–3765, 30–4185, 30–4470, 30–4496, 31–353). Several commenters objected to the burden of obtaining a written opinion from the HCP (see, *e.g.,* Exs. 30–3336, 30–4185, 30–4470, 30–4496). Tyson's foods believed that the requirement would be particularly onerous because

> [t]he proposed MSD management provisions also contemplate separate opinions for each MSD case. Under OSHA's injury and illness recordkeeping requirements, the identical condition may result in numerous OSHA recordable cases * * * requiring a separate written opinion for each case has the very real potential to create a mountain of paperwork for the same condition which may repeat itself throughout the year. (Ex. 30–4185).

Other commenters argued that the employer should not be required to tell the HCP what to provide (see, *e.g.,* Exs

30–1070, 30–2350, 30–4470, 30–4674, 32–234–2) and believed that if the HCP's opinion is incomplete, the employer should not be cited or otherwise be held accountable (see, *e.g.,* Exs 30–1070, 30–4470, 30–4674). The American Apparel Manufacturing Association asked ''If the HCP's written opinion fails to include all elements stated in [proposed] § 1910.932, should the HCP or the employer choosing that HCP be held responsible?'' (Ex. 30–4470). The Uniform and Textile Services Association added ''[e]mployers retain the responsibility for the opinions content but not the control over it. Employers will have no choice but to pay whatever fees HCPs impose to prepare reports * * *'' (Ex. 30–3336).

Other commenters stated that HCPs are reluctant to provide written opinions, and that HCPs are too busy to provide written documentation (see, *e.g.,* Exs 30–2350, 30–3231, 32–234–2). On the other hand, Tyson's Food remarked that the written opinion is not necessary because HCP's already keep written medical records and provide employees with access under the OSHA Standard 1910.1020 Access to medical records (Ex. 30–4185). Tyson's Food (Ex 30–4185) and Johnson & Johnson (Ex. 30–3347) provided identical comments expressing concern about which HCP needs to provide an opinion, remarking that:

> [f]or any given MSD complaint, there may be a nurse, in-plant physician, physical therapist, chiropractor, outside specialist physician, and outside physician selected by the employee, who are all involved in the treatment of a case * * * It is not clear who ''the'' [emphasis in original] HCP is when there are multiple HCPs involved in a case.

OSHA has carried forward the provisions that require the employer to obtain a written report from the HCP and provide a copy to the employee. A written report is needed so it is clear to all parties what needs to be done to resolve the employee's MSD. This opinion must be written because oral communication is more susceptible of misinterpretation. Employers must keep a record, and the easiest way to do this is if the opinion is in writing. OSHA recognizes that the requirement adds burden to the final rule, but believes that the need for the requirement outweighs the minimal burden imposed. OSHA does not find the argument that HCP's will be uncooperative or charge excessive fees to be persuasive. The employer has the right to select the HCP, and if the HCP is uncooperative or charges excessive fees, the employer is free to choose another HCP.

The written opinion must explain what actions the HCP recommends to resolve an MSD. These recommendations may include temporary work restrictions or the work the employee may do during the recovery period as well as the follow-up necessary to ensure that the MSD resolves. It is important that the HCP's opinion be provided in writing to the employer or the person(s) at the workplace who are responsible for carrying out the MSD management requirements of the standard. Employers need to know about the employee's medical condition to ensure that the restricted work activity they provide satisfies the HCP's recommendations, and whether the employee requires time away from work. The HCP's written opinion is especially important for the on-site person who is responsible for follow-up. That person needs to understand the HCP's plan for follow-up to make sure that the plan is implemented effectively. The information is also needed by the safety and health personnel who will be making workplace corrections. As the Organization Resource Counselors stated:

> OSHA seems to assume that an HCP will always be designated by the employer to take a key role in finding and fixing MSD hazards. In fact, in most cases, other professionals will be designated by the employer to assume this role. Therefore, they must be provided with meaningful information regarding the employee's capacity to perform various tasks (Ex. 30–3813).

As to the need to obtain a separate HCP opinion for each recordable MSD, the final rule does not use a recordable MSD as a trigger and the point is no longer valid. An HCP opinion is required only when an MSD incident occurs that exceed the action trigger. Likewise, it is not necessary for each and every HCP that is involved with the case to provide a written opinion. A written opinion from the primary treating HCP is needed to provide the employer with the basic information required by paragraph (q) of the final rule. If the initial is an occupational health nurse, and the case is referred immediately to a physician, there is no need for the occupational health nurse to provide a written opinion, the opinion of the physician will be adequate. Likewise, it makes no sense for a physical therapist or some other HCP who is strictly providing treatment to provide a written opinion. However, if the employer sends the employee to a specialist, a written opinion to the employer would be useful to see if the more specialized knowledge of the specialist HCP changes the need for restrictions, results in a different diagnosis, *etc.*

This paragraph also requires an employer to ensure that the employee promptly receives a copy of the opinion sent to the HCP. Several commenters opposed this provision (Exs. 30–3765, 30–4185, 30–4567), arguing that 29 CFR Part 1910.1020 gives better access to medical info (Exs. 30–4185), that oral communication between HCP and employee is adequate (Exs. 30–4185, 30–4567), that the employer should not be accountable for communications between the HCP and the employee, (Exs. 30–3765, 30–4567), and that similar problems in the bloodborne pathogens standard cause problems (Ex. 30–4567). In a representative comment, the American Ambulance Association stated that:

> A similar provision exists in the Bloodborne Pathogen standard and has been the cause for numerous violations by OSHA inspectors. This proposal will produce the same consequence. Note that during an examination and treatment by a healthcare professional, the employee and healthcare professional are present, while the employer is not. It is appropriate to assume that the healthcare provider communicates with the employee, just as healthcare professionals ordinarily communicate with patients.
>
> To interject the employer into the communications is ludicrous. To further require the physician to produce a written document, that is not produced in the ordinary course of business, and to require the employer to obtain that document and furnish it to the employee is a process fraught with error. If OSHA's intent is to assure that employees receive a written document from a healthcare provider, then OSHA should require the healthcare provider to produce the document and hand it to the employee (Ex. 30–4567).

It appears that these commenters did not realize that the only requirement put upon the employer is to simply provide a copy of the written opinion the employer receives to the employee. A separate written report for the employee is not required. OSHA continues to believe that a copy of the written report is essential if the employee is to participate in his or her own protection. It is particularly important for the employee to be knowledgeable about what work restrictions, if any, he or she has been assigned and for how long they will apply. Therefore, OSHA has included the requirement in the final rule.

Confidentiality for Non-Workplace Information

Paragraph (p)(5) requires employers to instruct the HCP that any findings, diagnoses, or information unrelated to workplace exposure to risk factors must not be included in the written opinion or communicated to the employer, except when authorized by state or federal law. The proposed rule contained a similar provision. This requirement is intended to encourage employees to disclose to the HCP all information about their health, and their activities both on and off the job, that could have a bearing on the MSD.

Full disclosure by employees will assist HCPs in evaluating the causal role of occupational risk factors and in determining the nature and duration of appropriate work restrictions. HCP's need this information to recommend work restrictions and follow-up that fit the employee's capabilities. This information will also enable the HCP to inform employees about activities, including non-work activities, that could aggravate the MSD and delay or prevent recovery. It is important for employees to know about any changes they can make to their on-and-off the job activities that will reduce their exposure to MSD hazards so that they may participate effectively in the recovery process. An example of an activity that sometimes must be postponed is a recreational activity that could place stress on the injured area of the body during the recovery period.

Employees will be reluctant voluntarily to disclose information about their health or outside activities if confidentiality is not maintained. MSDs may be associated with a variety of conditions, including hypertension, diabetes, kidney disorders and pregnancy, as well as the use of certain prescription drugs. See Ex. 30–3004 at p. 5; Ex. 30–3167. However, many employees would not want this health information revealed to their employers. The privacy protection accorded medical records under state and federal laws reflects general agreement that disclosure of information about a person's health status could result in embarrassment, stigmatization and discrimination in the workplace and elsewhere. See *Doe* v. *City of New York*, 15 F.3d 264, 267 (2d Cir. 1994) (''Extension of the right to confidentiality to personal medical information recognizes that there are few matters that are quite so personal as the status of one's health, and few matters the dissemination of which one would prefer to maintain greater control over.'') Similarly, information about employees' private off-the-job activities could be embarrassing and harmful if disclosed. Therefore, OSHA believes that it is important to preserve the confidentiality of personal information revealed by employees to the HCP that is not related to workplace exposure to MSD risk factors.

OSHA explained the need for this kind of privacy protection in the proposed rule, as follows:

> The confidentiality provision is necessary to ensure that employees will be willing to provide complete information about their medical condition and medical history. Employees will not divulge this type of personal information if they fear that employers will see it or use it to the employee's disadvantage. For example, employees may fear that their employment status could be jeopardized if employers know that they have certain kinds of medical conditions, which may be completely unrelated to work or exposure to MSD hazards, or if they are taking certain kinds of medication (*e.g.*, seizure medication, an anti depressant). In this sense, the ergonomics rule is * * * intended to be consistent with the confidentiality requirements of the Americans with Disabilities Act. 64 Fed. Reg. 65844.

OSHA recognizes that information subject to protection under the final rule may, in some circumstances, be disclosable under state or other federal law. For example, many state laws authorize the disclosure of medical information to employers in connection with workers' compensation claims. The agency does not intend the final rule's confidentiality requirement to conflict with state or federal law authorizing disclosure, and has included language to that effect in paragraph (p)(5).

The AFL–CIO supported the confidentiality requirement, noting that it is consistent with similar provisions in other OSHA standards and with guidelines in the American College of Occupational and Environmental Medicine (ACOEM) Code of Ethical Conduct (Ex. 500–218, p.117). Other comments were also supportive (See, *e.g.* Exs. 30–3686, 32–185–3–1). However, a substantial number of commenters were critical of the provision. These parties argued that prohibiting HCPs from disclosing information about the contribution of non-occupational risk factors will make it impossible for employers; (i) to determine whether a reported MSD is work-related, (ii) to comply with the final rule's requirements to monitor the condition of an employee with a work restriction to determine whether the MSD is resolving, and to institute effective hazard control measures for the problem job, and (iii) to evaluate a claim for workers' compensation benefits arising from the MSD. These arguments, and OSHA's responses, are discussed below.

1. Confidentiality and Work-Relatedness Determinations

A number of commenters argued that the confidentiality requirement would seriously hamper the employer in making determinations required by this final rule, and by the Recordkeeping rule in 29 C.F.R. Part 1904, about whether reported MSDs are work-related (see, *e.g.* Exs. 30–3004, 30–3061, 30–3086, 30–3167, 30–3177, 30–3231, 30–4334, 30–4564, 30–4674, 30–4713, 30–4843, 30–4844). Combe Inc. argued that:

> The unreasonable restraints the Proposed Standard places on the employer's ability to obtain information to meaningfully evaluate the work-relatedness of an employee's MSD claim further creates an environment of uncertainty and will force the employer into possibly unnecessary or deficient decision-making. Section 1910.932(a) of the Proposed Standard expressly provides that the HCP must be instructed 'that any findings, diagnoses or information not related to workplace exposure to MSD hazards must remain confidential and must not be put in the written opinion or communicated to the employer.' Thus, if Combe were to receive a single carpal tunnel syndrome complaint from an employee on one of its assembly lines * * * It would be barred from learning whether this employee has any of the non-occupational risk factors the scientific literature associates with the development of carpal tunnel syndrome * * * . Because the Proposed Standard would prohibit Combe from learning this essential non-occupational risk factor information or even from learning if the HCP inquired about this critical data or evaluated it properly, Combe would be unable to determine if the new claim is, in fact, the result of non-occupational factors or a deficiency in its heretofore successful ergonomic interventions (Ex. 30–3004, pp. 5–6).

In a similar vein, the Chamber of Commerce argued:

> [T]he fact that employers cannot receive any information related to non-work factors necessarily means that they will conclude that an employee complaint is work-related. After all, if employers are deprived of information about possible non work-related causes, what is left for them to consider? Regardless of the real cause of the muscluloskeletal complaint, in many cases employers will be forced to conclude that the injury is [work-related] because there will be—and because there can be—no evidence of exposures outside the workplace (Ex. 30–1722, p. 78).

These commenters correctly point out that employers must sometimes consider non-occupational factors, including pre-existing medical conditions, in deciding whether events or exposures at work ''caused or contributed'' to an MSD. See definition of the term *Work-related* in paragraph (z). However, they misunderstand the MSD management provision in arguing that the confidentiality requirement will deprive employers of information necessary to make work-relatedness determinations. The MSD Management provisions in paragraph (p), including the confidentiality requirement, apply when an employee has experienced an MSD Incident in a job that meets the Action Trigger. ''MSD Incident'' is defined to include only work-related MSDs meeting certain criteria. See paragraph (z). Therefore, the employer must decide that an MSD is work-related *before* it is required to implement the MSD Management requirements in paragraph (p).

Moreover, OSHA believes that it will rarely be necessary to delve into employees' private lives to make this determination. In most cases, employers will be able to decide if work is a contributing causal factor based on the type of injury and the nature of the employees' work activities. The final rule will facilitate this process because it includes a Basic Screening Tool that allows employers to determine whether risk factors are present in the job at levels of concern. In these cases, confidentiality protection is necessary to assure full disclosure to HCPs.

2. Confidentiality and the Employer's Duty To Follow-Up on the Employee's Recovery and To Control MSD Hazards

Some parties argued that the confidentiality requirement is fundamentally inconsistent with the duty imposed on the employer to check up on the progress of an employee with a work restriction to see that the injury is resolving, and to control the MSD hazards in problem jobs. The comment submitted by Layflat Products, Inc. is representative:

> OSHA cannot have it both ways. * * * Employers should not be forced to undertake workplace accommodations designed, at least in part, to enable the employee to continue to work without aggravating an MSD, or to provide an opportunity to recover, while at the same time effectively barring employers from having any effective means to prevent an employee from continuing to engage in conduct outside of work which the treating HCP has concluded and advised the employee will aggravate or prolong the MSD and, thereby, nullify the remedial efforts which the proposed standard would mandate the employer to take. * * * The preamble to the proposed rule also at least suggests that the employee's progress in recovery may have *some* bearing on the determination whether a proper ''job fix'' has been accomplished (Ex. 30–3061).

The NSBU voiced concern that ''numerous [health] conditions make contributions to musculoskeletal complaints. * * * In addition a vast number of outside activities engaged in by employees may contribute equally or much more substantially to such complaints. Yet employers—who would be required to march their workplaces along the path of incremental abatement at great cost and disruption—are not allowed to even contemplate the potential role of such individual pursuits, activities or conditions'' (Ex. 30–3167). (See also Exs. 30–1722, 30–3211, 30–3231, 32–337–1)

OSHA acknowledges that the confidentiality requirement is a compromise. At the same time, OSHA believes that confidentiality is essential to ensure employees' willingness to disclose personal health and other private information to HCPs, who, in many cases, make the initial recommendation about work restrictions. In OSHA's view, assuring that HCPs have access to information necessary to fulfill their central role in the MSD Management process is of overriding importance.

OSHA also believes that maintaining confidentiality in the personal information employees provide to HCPs will not seriously disadvantage employers. The purpose of work restriction requirements is to ensure that the injured employee's exposure to workplace risk factors is reduced or eliminated during the recovery period. The employer must know of the specific activities or motions to be restricted and what jobs, if any, satisfy these restrictions. Once the employee has been placed in a job that rests the affected area, or is removed from work entirely to recover, the employer's compliance obligation is satisfied, even if the employee's recovery is complicated by non-occupational factors. Thus, the confidentiality requirement should not hamper the employer's ability to comply with MSD Management requirements.

It is true that employers have a financial interest in ensuring that employees do not engage in non-work activities that could prolong the period for which WRP benefits must be paid. However, the final rule contains mechanisms to shield employers from the costs of prolonged WRP. The rule provides a procedure for HCPs to inform employees about medical conditions associated with exposures to risk factors, and any non-work activities that could impede their recovery. This information, conveyed directly by the HCP, will go far toward encouraging employees to seek appropriate treatment, and to refrain from potentially harmful outside activities during recovery. The rule also reduces the maximum duration of WRP benefits from six months, as proposed, to ninety calendar days.

OSHA has also addressed the concerns of some commenters that the confidentiality requirement could undermine employer's efforts to control MSD hazards. Under the proposed rule, employers could have been required to institute control measures incrementally when MSDs occurred in problem jobs. Commenters correctly pointed out that if the success of ergonomic interventions is to be measured by the occurrence of MSDs in problem jobs, employer knowledge about non-occupational factors associated with those MSDs assumes greater significance.

However, the final rule establishes different and more definite criteria for reducing MSD hazards. As explained in the preamble discussion of paragraph (k), the final rule sets out concrete steps that employers may take to reduce MSD hazards to acceptable levels. When employers take these steps, the occurrence of an MSD in the job does not require further action as long as the controls are still in place and functioning and no new hazards have arisen. OSHA believes that these changes, reflected in paragraph (k), address the concerns raised about the effect of the confidentiality requirement on the employer's hazard control obligation. For these reasons, OSHA concludes that preserving the confidentiality of information unrelated to occupational exposure to risk factors is necessary to effectuate the purposes of the standard and will not work an undue hardship on employers.

3. Confidentiality and Workers' Compensation

Finally, some commenters argued that the restrictions imposed upon HCPs' disclosure of information could preclude employers from evaluating workers' compensation claims arising from MSDs (see, *e.g.*, Ex. 30–4564, 31–324, 31–338). However, the final rule makes clear that the confidentiality requirement does not apply when disclosure is authorized by state or federal law. Thus, in a case involving a claim for workers' compensation benefits, the HCP is subject to the ordinary processes and procedures established by the state for obtaining relevant information. Nothing in the final rule is intended to conflict with, or hamper the operation of, state workers compensation systems.

Providing Information to the HCP

The final rule, like the proposed rule, requires the employer to provide information about the job and workplace conditions to the HCP conducting the assessment. The employer must provide the HCP with a description of the employee's job and information about the MSD hazards in the job and a copy of the ergonomics standard. These requirements to provide information to the HCP are slightly different than the proposed rule. The final rule does not carry forward the proposed requirements to provide a summary of the standard to the HCP, the requirement to provide workplace walkthroughs to the HCP, or the requirement to provide a description of available work restrictions.

Many commenters supported the proposed provisions pertaining to the information that must be provided to the HCP about the workplace (see, *e.g.*, Exs. 30–710, 30–3826, 30–3686, 30–4540), whereas others stated that some or all of the provisions in this paragraph should be deleted (see, *e.g.*, Exs. 30–3765, 30–3813, 32–300–1, 30–652). For example, the Dow Chemical Company suggested that OSHA delete this entire section, because (1) developing job descriptions would be burdensome, (2) gathering the information would create a time delay in getting an employee to an HCP, and (3) this information would not impact the quality of the care the injured employee receives (Ex. 30–3765).

Some commenters thought the requirement to provide information to the HCP was redundant with other requirements in the proposal or other existing OSHA regulations (see, *e.g.*, Exs. 30–3813). Others stated that creating and providing this material places a burden on employers (see, *e.g.*, Exs. 30–2725, 30–4567, 30–4607).

Information About the Employees Job and the MSD Hazards Within the Job

Both the final rule and the proposal require the employer to provide the HCP with a description of the employee's job and information about the MSD hazards in the job. This provision received very little specific comment. The only specific objection, made by several commenters, was that detailed job descriptions are not available (see, *e.g.*, Exs. 30–2725, 30–3392, 30–3765).

Paragraph (p)(3)(i) of the final rule requires employers to provide a description of the employee's job and information about the hazards in it. This information is needed to assist HCPs in providing both accurate assessment and effective management of MSDs. Without such information the HCP may not be able to make an accurate evaluation about the causes of the MSD or may not be able to prescribe appropriate restricted work activity. OSHA believes that providing HCPs with information about the results of any job hazard analysis that has been done in that job ensures that the HCP has the most complete and relevant information for evaluating and managing the recovery of the injured employee. Many stakeholders have told OSHA that they already provide this type of information to the treating HCP in order to familiarize the provider with the employee's job and associated workplace risk factors and ultimately to facilitate resolution of the MSD (Exs. 26–23 through 26–26).

If the HCP is already on site, he or she is likely to be familiar with the jobs in the workplace, the MSD hazards identified in the hazard determination of the employee's job, and what jobs or temporary alternative duty may be available. However, HCPs who are not routinely on site generally do not have this workplace-specific information and employers must provide it in these cases. It is essential that HCPs charged with the responsibility for MSD management know or be provided with this information if they are to successfully manage the cases of the injured workers. Because employers will have tested the injured employees job against the job hazard screen in paragraph (f), the employer will already have some idea of the hazards in the employee's job, and it should not be difficult to pass this information on to the HCP.

While some companies routinely keep detailed written job descriptions, other companies (especially small firms) may not have detailed written job descriptions immediately available. It is not vital that the employer provide the HCP with an enormously detailed description of the employee's job. A general description of the employee's job duties that contains enough detail to help the HCP perform an appropriate evaluation and develop an informed opinion of the case will suffice.

OSHA recognizes that this requirement places burdens on employers. However, the Agency believes these burdens are more than outweighed by the benefits that accrue from providing the HCP with information about the employees jobs and the MSD hazards in that job. As a recent journal article stated ''To make appropriate recommendations about return to work, the health care provider should know the physical demand characteristics of the job the worker is expected to perform'' (Ex. 502–284). Of course, the costs associated with this requirement have been included in the economic analyses for the final rule.

Copy of the Standard and a Summary of the Standard

The proposed rule would have required the employer to provide a copy of the ergonomics standard, as well as a summary of the standard, to the health care professional. The final rule simply requires the employer to provide a copy of the standard. Several commenters objected to the proposed requirements (Exs. 30–3765, 30–4567), arguing that they are not needed for diagnosis or treatment (Ex. 30–3765), are burdensome (Ex. 30–4567). The American Ambulance Association asked what would suffice for a summary of the standard (Ex. 30–4567). A few commenters suggested that OSHA create a non-mandatory appendix containing the required summary of the Standard (Ex. 30–3284, 30–3686, 31–307). Several commenters suggested deleting the requirement for a summary (Ex. 30–2216, 30–3813, 30–3922). For example, the Organization Resource Counselors argued that ''[t]he standard should be sufficiently straightforward [so] that the HCP can understand it without needing a special 'summary' of the standard'' (Ex. 30–3813). The A.O. Smith Corporation suggested that, as an alternative, OSHA could offer training to medical providers and certify them for this practice area (Ex. 30–2989).

OSHA has included the requirement to provide a copy of the standard to the HCP in order to assure that HCPs know how quickly employers must provide employees with access to the HCP and that employers must analyze any job in which an MSD incident is reported. Further, the HCP needs to be informed about the information they are to provide in the written report required by paragraph (q) of the final rule. OSHA has not included the proposed requirement to provide a summary of the standard to the HCP, finding that the summary is a redundant requirement that is not needed, since the standard itself is reasonably short and is easily read.

Descriptions of Available Restrictions

The proposed rule would have required employers to provide information on work restrictions that were available during the recovery period and that were reasonably likely to fit the employee's capabilities during the recovery period. OSHA believed that providing this information to HCP would help facilitate the appropriate matching of the employee's physical capabilities and limitations with a job that would allow an employee to adequately rest the injured area while still remaining productive in other capacities. Employers with ergonomics programs have discovered that the more detailed information and communication provided to the HCP about available alternative duty jobs, the better the HCP understands the causes of the problem and knows what work capabilities remain. As a result, these employers have found that the HCP is more likely to recommend restricted work activity rather than removal from work during the recovery period. In addition, it is more likely that HCPs are able to recommend much shorter removal periods when removal is combined with restricted work activity as a means of facilitating recovery.

A number of commenters argued that the employer cannot determine the need for restricted work, before an evaluation by a health care professional. (Exs. 30–1091, 30–1671, 30–3033, 30–3034, 30–3035, 30–3185, 30–3188, 30–3258, 30–3259, 30–3284, 30–3392, 30–3765, 30–3813, 30–4159, 30–4536, 30–4547, 30–4549, 30–4562, 30–4607, 30–4647, 30–4713, 30–4776, 30–4800, 32–300–1) In a representative comment, the Southern California Edison company remarked that:

> First, this calls for the employer to somehow anticipate the HCP's diagnoses and evaluation of physical limitations before the employer has even seen the HCP. Second, an HCP is better qualified to make an initial assessment of an employee's physical limitations (*i.e.,* lift no more than 10 pounds, do not stand for more than 4 hours, etc.). The employer then is best qualified to determine appropriate work restrictions taking into account the physical limitations described by the HCP (Ex. 30–3284).

OSHA agrees with these commenters that, for at least some MSD incidents, it is difficult to provide information about appropriate restrictions to the HCP, and that the HCP is in a better position to tell the employer what restrictions or physical restrictions must be implemented while the employee is recuperating from an MSD injury. Therefore, this provision has not been included in the final rule. However, the employer is required to implement any restrictions he or she finds necessary, and OSHA believes that there are some circumstances where the employer can implement restrictions before consultation with an HCP. The employer will also benefit from good communications with the HCP about what types of restricted work may be available, and should try to work cooperatively with the HCP to determine appropriate work.

Walkthrough Rights for the Health Care Professional

The proposed rule included a provision that would have required the employer to allow the health care professional to visit the establishment and walk through the establishment if the HCP wished to do so (64 FR 66073). OSHA's intent was to provide HCPs with opportunities to look at the problem job and the available alternative duty jobs. This would have allowed the HCP to become familiar with the physical work activities the injured employee performs, and allow that the HCP to see if available alternative duty jobs would allow the employee to rest the injured area during the recovery period. OSHA did not intend to require employers to provide HCPs walkthroughs throughout the entire facility, and expected that workplace walkthroughs could be either informal or formal. Several commenters supported the HCP walkthrough provisions (see, *e.g.*, Exs. 3–52, 3–107, 30–4301, 31–242). The Washington Federation of State Employees Local 1488—AFSCME also recommended that the employer should be required to pay for the HCP's time and travel expenses for a walkthrough (Ex. 31–242). The Dow Chemical Company said that it was not opposed to the proposed provision, and that DOW encourages HCPs to visit their worksites (Exs. 30–3765). Southern California Edison stated that they also did not object to the proposed requirement, but recommended that OSHA specify that the employer is under no obligation to pay the HCP for the walkthrough (Ex. 30–3284).

A few commenters opposed the proposed walkthrough rights requirement (Ex. 30–3348, 30–3749, 30–4713, 30–5674). Freeborn and Peters argued that the walkthrough rights are not needed (Ex. 30–4713). The Society for Human Resources Management stated that the proposed requirement:

> [w]ould be particularly burdensome for smaller employers who rarely have the kind of a relationship with an HCP that such a walkthrough would be practical. If OSHA chooses to maintain such a requirement, its application should be limited to larger employers and only for those HCPs whom the employer expects to use regularly * * * (Ex. 30–3749).

The Puerto Rico Manufacturing Association remarked that the proposed provision ''[n]eeds to be narrowed, because it is disruptive to many operations * * * '' and asked ''[w]hat if every employee with a sign or symptom wanted his own HCP to assess his job?'' (Ex. 30–3348).

OSHA has decided not to include an HCP walkthrough right in the final rule. While HCP walkthroughs have significant advantages in helping the HCP determine appropriate restrictions for injured workers, they are not absolutely necessary and could result in added burden to employers. As OSHA acknowledged in the proposal, there are other ways HCPs can acquire more in-depth information about the employee's job and the MSD hazards in it. For example, employers can provide HCPs with the results of the job hazard analysis, photographs of the job, or videotapes of the job being performed.

Paragraph (q). What Information Must the HCP's Opinion Contain?

Paragraph (q) describes the types of information that should be included in the HCP's written opinion. This information includes: (1) the HCP's assessment of the employee's medical condition as related to MSD hazards in the employee's job; (2) any recommended work restrictions, including, if necessary, removal from work to allow for recovery, and any follow-up needed; (3) a statement that the HCP has informed the employee of the results of the evaluation, the process to be followed to effect recovery, and any medical conditions associated with exposures to risk factors; and (4) a statement that the HCP has informed the employee about work-related or other activities that could impede recovery from the injury.

These four elements to be addressed in the HCP's opinion were included in the proposal, and OSHA received no significant comment requiring discussion in the final rule. OSHA notes that ''work restrictions'' are defined in paragraph (z) of the final rule as limitations on the employee's exposure to risk factors present in the job giving rise to the MSD incident, and may include limitations on work activities in the current job, transfer to an alternative duty job, or complete removal from work to permit recovery. OSHA reiterates here the point made in the proposal about the importance of specific work restriction recommendations. 64 Fed. Reg. 65,845. The HCP should describe in as much detail as possible the nature and duration of work restrictions so that employers will have maximum flexibility to ensure that employees can remain productive while resting the affected area.

Paragraph (r) What Must I do if Temporary Work Restrictions or Removal From Work are Needed?

Paragraph (r) describes the actions required when an MSD incident has occurred in a job with risk factors that exceed the action level, and the employer or HCP determines that temporary work restrictions or removal from work are needed.

Paragraph (r)(1) first makes clear that the employer must either determine the work restriction or removal himself or herself, or comply with the recommendations of an HCP, either by temporarily placing the injured employee in an appropriate alternative or ''light duty'' job, or, if necessary, by temporarily removing the employee from work.

Paragraphs (r) (2) and (3) require the employer to maintain the injured employee's wages and benefits when work restrictions are necessary.

Work Restriction Protection (WRP)

A. Necessity for WRP

''Work restriction protection'' or ''WRP'' refers to the requirements in paragraphs (r)(2) and (3) for maintaining an injured employee's employment rights, wages and benefits when temporary work restrictions are necessary. As explained in the proposed rule, 64 FR 65848–65852, and in the discussion below, WRP requirements are designed to encourage employees to report MSDs and their signs and symptoms as early as possible, and to participate actively in MSD management. Early reporting of MSDs by employees will contribute to the success of the final rule in several important ways. First, unlike other OSHA standards, the rule does not require employers to monitor their workplaces for hazards, but rather to evaluate employee reports of MSD signs or symptoms to determine whether further action is necessary. Employee reports must be evaluated to determine whether an MSD incident has occurred in a job with risk factors exceeding the standard's action level. If the job has risk factors that exceed the action level, the employer must implement several elements of an ergonomics program, including job hazard analysis, and must provide necessary work restrictions (including work removal, if necessary) and MSD management.

This approach depends upon employees' willingness voluntarily to report when they first experience signs or symptoms at work. As the agency noted in the proposed rule, ''[i]f employees are not willing to come forward and report MSDs, serious MSD hazards in that job will go uncontrolled, thus potentially placing every employee in that job at increased risk of harm.'' 64 FR 65861. Early reporting permits employers to identify problem jobs and institute corrective measures before other employees in those jobs become injured. Thus, timely reporting by employees is central to the final rule's hazard identification and control mechanisms.

Early reporting is also crucial in maximizing the standard's benefits for injured employees and in minimizing costs to employers and employees. The record establishes that MSD treatment is more likely to be successful if provided early, before the disorder has become debilitating (see *e.g.*, Exs. 3–56; 3–59; 3–179; 3–184. See also Testimony of Dr. Evanoff (Tr. 1530–31; 1628); Dr. Herbert (Tr. 1698–99); Dr. Connell (Tr. 2833); Dr. McCunney (Tr. 7649–50); Dr. Bernacki (Tr. 7687); Dr. Piligian (Tr. 7883–5); Dr. Frank (Tr. 1388); Dr. Cherniak (Tr. 1234–5). Early detection and intervention also reduces the severity of MSDs and the level of treatment required to address them (see *e.g.*, Exs. 3–23; 3–33; 3–50; 3–56; 3–59; 3–121; 3–124; 3–151; 3–162; 3–179; 3–184) and reduces the number of days employees must spend on restricted duty or away from work entirely (see Ranney 1993, Ex. 26–913; Day 1987, Ex. 26–914; Oxenburgh 1984, Ex. 26–1367). Consequently, the early reporting of MSDs substantially reduces both the physical and economic toll of these disorders.

The participants in the rulemaking had conflicting views on whether, and to what extent, WRP is needed to ensure early reporting of MSDs. After a careful review of the literature, testimony and comments on this issue, OSHA finds persuasive evidence that, without WRP, employees will be reluctant to report MSDs and their signs and symptoms at an early stage. In the preamble to the proposed rule, OSHA discussed a variety of studies in the scientific literature indicating that MSDs are underreported in federal and state occupational injury and illness statistics. These studies show that a substantial percentage of work-related MSDs are not recorded on the OSHA log of occupational injuries and illnesses, and are therefore excluded from the Bureau of Labor Statistics (BLS) data (see *e.g.*, Exs. 26–28; 26–1258; 26–920; 26–922; 26–1259; 26–1261; 26–1260). They also demonstrate that large numbers of workers with medically confirmed MSDs do not file claims for workers' compensation benefits (see *e.g.*, Exs. 26–1258; 26–1212; 26–920). See also 64 FR 65851–52; 65980–83 and Table VII–2. Based on this and other evidence, OSHA preliminarily estimated that at least half of all work-related MSDs are not reflected in the BLS statistics. 64 FR 65981.

Researchers, physicians, and workers themselves supported OSHA's finding that MSDs are underreported at the federal and state levels. NIOSH agreed that there is a substantial likelihood that the actual number of MSDs exceeds the BLS estimates, and that this is due in part to underreporting of the true number of work-related health problems on the OSHA 200 logs (Ex. 32–450–1). Other commenters highlighted the growing literature in the workers' compensation field, including recent studies confirming that only a small percentage of workers with back, upper extremity and other MSDs file claims for benefits (see *e.g.*, Ex. 37–14, p. 9 [Emily Spieler, citing, *e.g.*, Morse 2000]; Ex. 500–203 [Dr. Michael Erdil, citing, *e.g.*, Rosenman 2000]; Ex. 32–339–1, Ex. 500–218; Tr. 2399–2301 [Dr. Boden]).

Physicians and researchers testified that the findings in the literature were consistent with their experiences (Tr. 839–40 [Dr. Armstrong]; Tr. 1021 [Dr. Punnett]; Tr. 1115 [Dr. Erdil]; Tr. 1886–87 [Dr. Owen]; Tr. 2399–2401 [Dr. Boden]). Dr. Michael Erdil stated that ''my clinical experience as an occupational physician treating thousands of patients with MSDs is consistent with these studies' finding that employees often do not report MSDs they believe to be caused by work.'' Tr. 1115. Emily Spieler, an author and lecturer on workers' compensation issues, and a former Commissioner of the West Virginia Workers' Compensation Fund, wrote that

> [t]he findings regarding under-filing are consistent with my own observations regarding workers' claims filing behaviors. Many workers with compensable injuries do not file claims for benefits. Both my own experience and current literature suggest that under filing far exceeds overreporting in workers compensation systems. There are serious implications regarding the prevention and compensation of MSDs that flow from this.

Ex. 37–14, p. 10.

Workers have given a variety of reasons for not reporting MSDs to their employers or failing to seek workers' compensation benefits for these disorders (see 64 FR 65849–50; 65980–81). Many workers expressed the fear that if they report a work-related injury, they will lose their job or be transferred to an alternative job at reduced pay and benefits, or suffer other forms of job discrimination (see Exs. 3–121; 3–151; 3–183; 3–184; 3–186). Employees voiced these concerns repeatedly during the hearing (see Tr. 3602 [Corey Thompson]; Tr. 5820 [Dave [S]aksewski]; Tr. 5832 [Scott Bean]; Tr. 6022 [Dennis Norton]; Tr. 5901–02 [Victor Henderson]; Tr. 7733–34 [Sandy Brooks]; Tr. 7736–37 [Jeanette Di Florio]; Tr. 7545–46 [Penny Siedner]; Tr. 7998 [Al Close]; Tr. 8013 [Bob Zielonka]; Tr. 9561 [Robert Wabol]; Tr. 10,720–21 [Richard Sorokas]; Tr. 12,530 [Buzz Vsetecka]). Dave [S]aksewski recounted his experience at an automobile assembly plant:

As I was new in the facility, I received many less than desirable jobs. On many of the assembly jobs my hands or arms ached at the end of the shift or my back was so sore from lifting that I could not do the things on weekends that I would have enjoyed doing and I had normally done in the past. Things like fishing or playing ball went on the back burner until I felt like I could do them without further hurting myself.

I never reported any of these problems to the medical department because as a probationary employee you just did not complain about anything, even if I was a union member. * * * The end result of a complaint from me would have been no overtime, maybe a job restriction, or a disputed compensation claim that I had injured myself at home working in the garden.

I can tell you from personal experience that people do not report MSDs until they get bad enough where they can no longer tolerate the job.

Tr. 5822–23. Autoworker Al Close agreed, stating ''employees are still reluctant to report early symptoms of injury. This is due to intimidation by middle management and by the fact that they will get work restrictions or be sent home with the loss of pay.'' Tr. 7998. Employee representatives from a broad spectrum of industries echoed these sentiments (see *e.g.*, Ex. 32–182–1 [AFSCME]; Ex. 32–185–3 [UAW]; Exs. 32–339–1; 500–218 [AFL–CIO]; 32–198–4 [UNITE]).

Employers, physicians, and others acknowledged that concerns about economic loss and retaliation influenced employees' decisions not to report their MSDs or to seek treatment or compensation for them. Peter Meyer, Human Resource Director for Sequins International testified:

It is true that workers in most situations don't report pain and work-related injuries, especially when they are concerned about their jobs. They are continually concerned about the hours that they are going to work so it makes sense that workers wouldn't report something that they might think jeopardizes their jobs.

Tr. 17350. Dr. George Piligian testified that the most common reason given by employees for delaying treatment for MSDs was the fear of losing income. He stated, ''[t]his was the biggest obstacle, especially in those that were not high-paying sectors of the work force. Therefore, wage replacement, especially when you first have symptoms, is vital. People will not come forth.'' (Tr. 7822–3). See also Tr. 1115 (Dr. Erdil); Tr. 1724 (Dr. Robin Herbert).

This evidence demonstrating that economic concerns are a powerful motivating factor in workers' behavior affecting their health is consistent with that adduced in previous OSHA rulemakings. For example, OSHA commented on the evidence that lead-exposed workers would be reluctant to participate in medical surveillance program, as follows:

Much of the evidence in the lead proceeding documents the extent to which worker participation is adversely affected by the fear that adverse employment consequences will result from participation in medical surveillance programs. This problem was emphasized by the testimony of many workers and worker representatives. * * * Evidence concerning the issue of worker fear impeding participation, however, was not confined simply to testimony from worker representatives. A wide variety of experts verified the existence of this problem, as did several industry representatives. The evidence suggests that economic disincentives to worker participation are currently a problem in the lead industry.

43 FR 54442.

OSHA believes that the two patterns of employee behavior discussed above—the failure to report work related MSDs to employers, and the failure to claim workers' compensation benefits for these disorders—underscore the need for WRP in the final rule. OSHA's recordkeeping regulations in Part 1904 already require employers to inform employees of the need to report injuries and illnesses promptly, and to have a clear procedure for reporting. Moreover, section 11(c) of the OSH Act protects employees who report their injuries from acts of discrimination or retaliation by employers. In view of the evidence that these provisions do not eliminate underreporting on the OSHA logs, it is unreasonable to believe that similar requirements and protections in the final rule, standing alone, will be sufficient. Indeed, without wage protection, the standard's MSD management provisions, including mandatory work restrictions or work removal when recommended by an HCP, will likely increase the pressure on employees not to inform their employers of work-related MSDs, and thereby exacerbate an already serious problem.

The evidence on employees' dissatisfaction with workers' compensation benefits, and avoidance of workers' compensation systems, is also relevant. There was substantial testimony that employees view the workers' compensation system as ineffective and cumbersome to use (see *e.g.,* Ex. 500–218). Emily Spieler summarized these problems as follows:

There are several tiers of problems with the adequacy of compensation, for both compensatory and deterrent effects. First, many people do not file claims that, if filed, might be compensable. Second, in some states, many claims involving work-related MSDs may not be compensable, even if filed. Third, payment in apparently compensable claims for MSDs, and in particular for repetitive stress-related MSDs, may not be paid due to controversion, or may be delayed, or may be settled for compensation below the statutory amounts.

The result is twofold. First, workers may be discouraged from filing workers' compensation claims or from otherwise alerting their employers to developing MSDs. Second, workers compensation fails to provide employers with adequate incentives for the prevention of disabling MSDs.

Ex. 37–14, p. 10. This evidence demonstrates that the potential availability of workers' compensation benefits alone is insufficient to ensure full and timely reporting of MSDs and their signs and symptoms, and further underscores the need for a requirement protecting employees' wages and benefits during periods when work restrictions are necessary.

In contrast, OSHA was not convinced by those commenters who argued that the record does not demonstrate the need for WRP. The evidence and argument presented by these commenters was not as concrete or specific. They maintained principally that: (i) OSHA's own audits conducted in 1996 and 1997, and statements made by some OSHA officials and experts, demonstrate that employer logs are accurate; (ii) there is no need for WRP because most MSDs require little or no time away from work; and (iii) OSHA itself concluded that WRP will not rectify underreporting. These arguments are discussed below.

In 1998 and 1999, OSHA performed audits of employers' injury and illness records. The 1998 audit examined a sample group of employers' 1996 records, while the 1999 audit examined records for 1997 (see Ex. 500–168, Appendices A and B). A number of commenters argued that the results of these audits undermined OSHA's finding of widespread underreporting of MSDs on employers' logs (see *e.g.,* Exs. 500–168; 30–3347; 32–78–1; Ex. 30–1722; Ex. 30–3956). The AISI's comment is representative:

OSHA went to extensive lengths to perform a statistically significant audit of the accuracy of OSHA 200 recordkeeping. The results of the official OSHA audits of OSHA 200 logs for 1996 and 1997 are compelling. OSHA found that, at the 95% threshold of accuracy, the percentage of establishments with accurate records [for total recordable cases (TR) and for lost workday cases (LW)] was [for 1996, 87.96% TR and 86.57% LW; for 1997, 91.93% TR and 89.69% LW] * * *. Based on * * * review of the studies cited by OSHA [in the proposal], it is clear that they do not support OSHA's allegation of a substantial and widespread underreporting of occupational injuries and illnesses. Rather than looking back to limited reviews of ''ancient history,'' OSHA is required to look at the best available evidence, which is the 1996 and 1997 audit reports. They demonstrate an extremely high level of accuracy in OSHA 200 recordkeeping from samples determined to be representative * * *.

Ex. 500–168, pp. 9–10, 21. The ORC also pointed to OSHA's audits:

[t]he [audit] process is centered around comprehensively checking both occupational and nonoccupational injury and illness records to identify misreporting and under reporting. Employee interviews are also used when the compliance staff deems them necessary. The results from the audits provide the only statistically reliable insights available into the quality of the OSHA data and the accuracy of employee reporting and employer recording practices.

Ex. 32–78–1 at 27. ORC noted that most of the studies cited by OSHA examine data that is more than a decade old and that may not reflect improvements due to the Agency's stepped-up recordkeeping enforcement efforts and recent guidance on the proper recording of cumulative trauma disorders (Ex. 32–78–1, p. 26). ORC and others also noted that Agency officials, including Assistant Secretary Charles Jeffress, have expressed confidence in the accuracy of BLS statistics (see *e.g.,* Exs. 32–78–1, p. 27; 30–1722, p. 75–76; 30–3347).

OSHA's recent recordkeeping audits were designed to measure whether employer records accurately reflect injuries and illnesses that employees reported to them. Therefore, the auditors examined occupational records to identify the work-related injuries and illnesses that may have occurred to employees, including, where available, medical records, workers' compensation records, insurance records, payroll records, company safety incident reports, first-aid logs, and light duty rosters (Ex. 500–168–1, Appx. *Analysis of Audits on 1996 Employer Injury and Illness Recordkeeping, Audit Protocol* at 6, (v)). The audit protocol did not require the auditors to examine non-workplace records to determine whether employees within the sample group had suffered work-related MSDs which were not reported because the employees did not seek treatment from the employer or the employers' health insurance, file a worker's compensation claim, take leave, or otherwise enter the employer's records. Id. By contrast, a number of studies in the record examine non-workplace records and other sources in determining that MSDs are not accurately reflected in the OSHA logs. For example, in performing health hazard evaluations (HHEs) at several establishments, NIOSH found that a high proportion of MSDs reflected in the records of employees' private health care providers, in confidential interviews, and in standardized questionnaires and surveys were not included in the employers' logs. NIOSH reported that:

These HHEs compared the OSHA 200 logs with work-related MSDs ascertained via the following mechanisms: (1) confidential medical interviews; (2) review of employee medical records of private health care providers; (3) health surveys utilizing standardized MSD symptom questionnaires; (4) health surveys defining cases as those with work-related symptoms and positive physical findings conducted by physicians performing physical examinations targeted to the musculoskeletal systems. We have no reason to believe that these HHEs are not representative of the likely widespread under-reporting of work-related MSDs.

Ex. 32–450–1. Moreover, several of the studies discussed in the proposed rule examine data sources that appear to be different from those considered in OSHA's audits (see *e.g.,* Exs. 26–28; 26–1261; 26–1259; 26–1250).

For these reasons, OSHA believes that the recent audits do not undercut the findings in the literature that widespread underreporting exists. The logs are a reasonably accurate reflection of those injuries and illnesses actually reported by employees at work.[13] OSHA believes that many recordable MSDs are omitted from OSHA logs and other workplace records because employees do not inform their supervisors, do not file a claim for workers' compensation, or do not seek treatment from the employer's medical staff or health insurance provider. This is apparent not only from the studies examining the logs, but also from the evidence on employee reporting behavior in the workers' compensation field, and the direct testimony of many workers themselves during the hearing. Considering the record as a whole, OSHA finds that there is reliable, persuasive evidence that MSDs are currently underreported in the OSHA injury and illness records.

Employer representatives also argued that OSHA's estimate in the proposed rule that ''most MSDs do not result in any days away from work'' (64 FR 65853) undermines the need for WRP (Exs. 32–211–1; 30–1722). The Chamber of Commerce argued that ''[b]oth * * * propositions cannot be true: either large numbers of employees are refraining from reporting lost-time injuries to avoid significant financial losses, thus requiring WRP, or few such losses are occurring—which means that [the] WRP provision is unnecessary.'' (Ex. 30–1722, p. 77.).

[13] The audits show that approximately 10% or more of injuries and illnesses reported by employees are not recorded in the logs.

OSHA does not believe that the two propositions cited by the Chamber are inconsistent. As discussed above, a significant factor motivating employees not to report MSDs is the fear that they will be placed in a restricted duty job with reduced pay and benefits, and that they may also lose seniority or ''bidding'' rights. Thus, employees' concern about being out of work altogether is not the only, or necessarily the predominant, factor to be considered in evaluating the need for WRP. Moreover, there is no fundamental tension between OSHA's conclusion that workers' fear of economic loss is a significant contributing factor to the high level of underreporting observed in the literature, and its estimate that most MSDs will not result in time away from work. As discussed further in the Significance of Risk and the Benefits chapter of the Final Economic Analysis supporting this rule, a significant proportion of all MSDs (approximately one-third) will result in some lost work time, and certain types of MSDs, such as carpal tunnel syndrome, require nearly a month to recover sufficiently to return to work (median length of time away is 25 days). Therefore, the prospect of losing work due to an MSD is a tangible one, and serves as a powerful stimulus to employees. Indeed, the record evinces strong and deeply held beliefs by many employees across industry sectors that reporting MSDs and their signs and symptoms will result in loss of pay and benefits, or other adverse employment action. Accordingly, concrete wage and benefit protections are necessary to counter employees' concerns about reporting MSDs.

Some commenters argued that there is no justification for requiring WRP in light of OSHA's preliminary conclusion that WRP would not increase the MSD reporting rate (see *e.g.,* Exs. 32–211–1, p. 9; 32–234–2, p. 27). In the Preliminary Economic Analysis of the proposed rule, OSHA explained that it was then unable to quantify the incentive effects of WRP on employee reporting of MSDs, and therefore had no basis to estimate the costs and benefits attributable to increased numbers of MSDs reported (64 FR 66001). However, the agency ''welcome[d] data and comments on the extent of MSD under reporting, possible increases in the reporting of MSDs that may occur after employers implement an ergonomics program, and on the incentive effects of the proposed standard on employee reporting of MSDs.'' Id.

As explained in the Final Economic Analysis, OSHA has identified several studies from the economics literature permitting the Agency to develop a methodology that enables it to estimate the impact of WRP on MSD reporting rates. Because wage and benefits protection requirements will likely substantially increase the number of employees who will report MSDs and their signs and symptoms, WRP is a reasonably necessary and appropriate component of the final rule.

B. Legal Authority for WRP

1. The OSH Act and Past OSHA Practice Require That OSHA Include WRP In This Standard

It is now well established that OSHA's authority to promulgate occupational safety and health standards ''reasonably necessary or appropriate to provide safe or healthful employment and places of employment,'' 29 U.S.C. § 652(8), encompasses the authority, in appropriate cases, to include WRP provisions in those standards. Section 6(b)(7) provides that a standard should, ''[w]here appropriate * * * prescribe suitable * * * control * * * procedures'' to prevent hazards. 29 U.S.C. § 655(b)(7), and Section 8(g)(2) of the OSH Act provides that ''[t]he Secretary * * * shall * * * prescribe such rules and regulations as he may deem necessary to carry out his responsibilities'' under the statute. 29 U.S.C. § 657(g)(2). These provisions give OSHA broad authority to require employers to implement practices, such as WRP, that are reasonably necessary or appropriate to achieve OSHA's statutory mission—providing safe or healthful employment and places of employment. See 64 FR 65848–53 (Nov. 23, 1999).

Relying on both this statutory language and the OSH Act's legislative history, the D.C. Circuit affirmed a WRP provision in OSHA's 1978 lead standard requiring employers to maintain an employee's earnings and other rights and benefits during a work removal period of up to 18 months. *United Steelworkers of America* v. *Marshall (Lead),* 647 F.2d 1189, 1230 (D.C. Cir. 1980), cert. denied, 453 U.S. 913 (1981). [Note: In the lead standard, the provision at issue was termed medical removal protection (MRP).] The court held that (1) the OSH Act gives OSHA broad authority to include WRP where necessary or appropriate to protect the health of workers, and (2) OSHA's inclusion of WRP in the lead standard was supported by the rulemaking record. Id. at 1228–40. The court held that ''OSHA's statutory mandate is, as a general matter, broad enough to include [WRP].'' *Id.* at 1230. The court also found that OSHA had met its burden of demonstrating that WRP was reasonably necessary and appropriate by providing evidence that employees would resist cooperating with the medical surveillance program in the lead standard absent assurances that they would have economic protection in the event of a medical removal. *Id.* at 1237.

OSHA has followed a consistent practice of including WRP provisions in standards when the rulemaking records show that the provision is useful or necessary to achieve the purposes of the standard. OSHA has included similar WRP provisions in numerous other standards. See *e.g.,* 29 CFR 1910.1025 (Lead); 29 CFR 1910.1027 (Cadmium); 29 CFR 1910.1028 (Benzene); 29 CFR 1910.1050 (Methylenedianiline); 29 CFR 1910.1052 (Methylene Chloride). OSHA's inclusion of WRP in those standards was based upon findings that absent some wage protection employees would not participate in the medical surveillance provisions of the standards. See *e.g.,* Lead preamble, 43 FR 5440 (Nov. 21, 1978).

In 1987, OSHA omitted a WRP provision from its formaldehyde standard on the bases that the ''nonspecificity of signs and symptoms [made] an accurate diagnosis of formaldehyde-induced irritation difficult,'' the symptoms of formaldehyde exposure often quickly resolved, and some employees would never be able to return to a work environment that contained any formaldehyde. 52 FR 46168, 46282 (Dec. 4, 1987). On review, however, the D.C. Circuit held that these justifications, which it characterized as ''feeble'' or ''vague and obscure,'' were inadequate to justify OSHA's ''swerve'' from past practice. See *International Union* v. *Pendergrass (Formaldehyde),* 878 F.2d 389, 400 (D.C. Cir. 1989). The court remanded the issue for OSHA's further consideration. OSHA eventually included a WRP provision in the standard:

> On reconsideration, the Agency has concluded that [WRP] provisions can contribute to the success of the medical surveillance programs prescribed in the formaldehyde standard. Unlike some other substance-specific standards, the formaldehyde standard does not provide for periodic medical examination for employees exposed at or above the action level. Instead, medical surveillance is accomplished in the final rule through the completion of annual medical questionnaires, coupled with affected employees' reports of signs and symptoms and medical examinations where necessary. This alternative depends on a high degree of employee participation and cooperation to determine if employee health is being impaired by formaldehyde exposure. OSHA believes these new [WRP] provisions will encourage employee participation in the standard's medical surveillance program and avoid the problems associated with nonspecificity and quick resolution of signs and symptoms that originally concerned the agency. 57 FR 22290, 22293 (May 27, 1992).

Formaldehyde makes clear that OSHA may not decline to include WRP in standards absent specific findings justifying such a ''swerve'' from past practice. The rulemaking record here does not support such a ''swerve'; to the contrary, it shows that WRP could serve functions strikingly similar to those it serves in the formaldehyde standard. Substantial evidence shows that MSDs are currently underreported and that a significant reason for this underreporting is employees' fear that they will lose income, or even their jobs. In order to encourage employees to report MSDs, report them at an early stage, and participate in MSD management, OSHA must include WRP in this standard.

Despite the legal principles described above, however, a number of rulemaking participants argued that OSHA does not have authority to include WRP in this standard. Their reasons ranged from factors specific to this rule to more general assertions that OSHA never has authority to require WRP, and that the cases holding to the contrary were wrongly decided. OSHA responds to these comments below.

Some commenters stated that OSHA does not have authority to include WRP (or even provisions for work restrictions) in this standard because there are no ''objective'' triggers for removal. See *e.g.,* Ex. 500–188, p. 87. These commenters contended that in every other standard where OSHA has included a WRP provision, OSHA established (1) an ''objective'' exposure level for removal, and (2) ''objective'' medical criteria for removal. In this standard, they argued, employers will be forced to remove employees from work based solely on reports of ''subjective symptoms.'' Ex. 30–4467, pp. 17–18.

This argument is based on erroneous conceptions of the WRP provisions in both OSHA's earlier standards and this one. First, other standards frequently require removal based upon a physician determination that removal is appropriate, even without ''objective'' triggers. In the lead standard, for example, an employee can be removed from work when ''a final medical determination results in a medical finding * * * that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.'' 29 CFR 1910.1025(k)(1)(ii). This determination does not have to be based on objective tests; rather, it can be based upon a physician's independent judgment. In the Cadmium standard, an employee can be removed based upon ''signs or symptoms of cadmium-related dysfunction or disease, or any other reason deemed medically sufficient by [a] physician.'' 29 CFR 1910.1027(11)(i)(A); see also Methylenedianiline 29 CFR 1910.1050(9)(i)(B)(1) (removal shall occur ''on each occasion that there is a final medical determination or opinion that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to MDA'').

Second, this standard does not require employers to provide WRP to employees based solely on employee reports of ''subjective'' symptoms. The employer makes the determination of whether an employee's report qualifies as an MSD incident under this standard. See Paragraph (e). Employers can seek assistance in making these determinations by referring employees to a health care professional. In the end, however, it is the employer's decision. Moreover, this final standard includes an Action Trigger in paragraph (f). If an employee who has suffered an MSD incident is not exposed on his or her job to risk factors at levels that exceed those on the screening tool in Table 1, the employer has no WRP obligations. See Paragraph (f).

In any event, neither the OSH Act nor any of the court decisions interpreting OSHA's authority suggest that OSHA's WRP authority is limited to protecting workers only against conditions that are easy to diagnose. On the contrary, the OSH Act gives OSHA broad authority to include provisions in standards that are reasonably necessary and appropriate to effectuate its statutory mandate. OSHA has found, based upon substantial evidence in the rulemaking record, that WRP is necessary to the effectiveness of this standard. This finding is not affected by the presence (or absence) of ''objective'' baseline tests for certain MSDs or the presence (or absence) of ''objective'' or baseline levels for removal.

Some commenters argued that OSHA does not have authority to include WRP in this standard because employees are exposed to some of the hazards at issue outside of the workplace. See *e.g.,* Ex. 500–197, p. III–76. But while it is true that OSHA may only regulate ''conditions that exist in the workplace,'' *Industrial Union Dep't, AFL–CIO* v. *American Petroleum Institute et al.*(Benzene), 448 U.S. 607, 642 (1980), OSHA is not precluded from regulating such conditions just because they may also exist outside the workplace. *Forging Industry Assn.* v. *Secretary of Labor (Noise),* 773 F.2d 1436, 1442 (4th Cir. 1985). OSHA's Occupational Noise standard, for example, establishes certain requirements that must be met to prevent or reduce the incidence of hearing impairment, a condition that can also be caused by exposure to excessive noise levels outside of work. And OSHA has previously required WRP where employees are also exposed to the hazard at issue outside of the workplace. For example, employees may be exposed to lead, cadmium, methylene chloride, and formaldehyde in varying degrees outside of work. In this case, OSHA has properly exercised its authority to regulate ergonomic hazards in the workplace. The OSH Act thus does not prevent OSHA from including WRP in this standard merely because employees may be exposed to some ergonomic risk factors outside of work.

OSHA also does not agree that it may not include a WRP provision in a standard that is not promulgated pursuant to section 6(b)(5) of the OSH Act. Ex. 500–223, pp. 81–82. OSHA's authority to include WRP in this standard derives from numerous provisions of the OSH Act, including sections 3(8), 6(b)(7), and 8(g)(2). These provisions give OSHA broad authority to implement measures reasonably necessary or appropriate to effectuate its statutory goal. OSHA's authority to include WRP is not granted by section 6(b)(5) of the OSH Act or limited to standards promulgated pursuant to section 6(b)(5). Section 6(b)(5) applies to toxic materials and harmful physical agents and requires OSHA to ''set the standard which most adequately assures, to the extent feasible * * * that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard * * * for the period of his working life.'' 29 U.S.C. 655(b)(5).

To be sure, OSHA has previously required WRP only in section 6(b)(5) standards. But the reason for that inclusion was record evidence that absent some wage protection employees would not participate in the medical surveillance or medical management programs of those standards. Non-section 6(b)(5) standards, on the other hand, do not include medical surveillance provisions. OSHA has thus found it unnecessary to include WRP in those standards. OSHA's past practice does not indicate that WRP can only be included in section 6(b)(5) standards; rather, it demonstrates that WRP can only be included in standards based upon findings that it is reasonably necessary or appropriate. OSHA has made those findings here.

Some commenters argued that Congress' establishment of the National Commission on State Workmen's Compensation Laws (National Commission) in the OSH Act to examine the effectiveness of state workers' compensation systems suggests that Congress did not want to ''federalize'' workers' compensation through a provision such as WRP. Ex. 30–3811, pp. 15–16. But Congress established the National Commission to provide an ''objective evaluation of State work[ers'] compensation laws in order to determine if such laws provide an adequate, prompt, and equitable system of compensation for injury or death arising out of or in the course of employment.'' See 29 U.S.C. 676. In Lead, the D.C. Circuit examined whether Congress's establishment of the National Commission demonstrated a legislative hostility to WRP. The court held that it did not. Lead, 647 F.2d at 1235 n.70. Of particular importance to the court was that WRP did not ''federalize'' workers' compensation, rather it left the state workers' compensation scheme wholly intact as a legal matter. Id. Thus, even if Congress evinced a hostility to the ''federalization'' of workers' compensation through the OSH Act, the WRP provision at issue did not effect such ''federalization.'' Id.

Similarly and as explained in more detail below, WRP in this standard will not affect or supersede workers' compensation systems; nor will WRP have a great practical effect on workers' compensation. WRP is not designed to ''compensate'' workers who suffer from MSDs, to provide them with medical treatment for their work-related injuries or illnesses, or to determine the extent of their disability, all functions reserved to workers' compensation; WRP is designed to encourage employees to report MSDs early and participate in MSD Management. In that sense, WRP serves as an administrative control, working to prevent injuries from becoming disabling and compensable.

NCE *et al.*also claimed to find additional evidence that Congress did not intend OSHA to have authority to require WRP in Congress' refusal to include the ''Daniels Amendment'' in the OSH Act. Ex. 500–197, pp. III–73–

80. The Daniels Amendment would have required the Secretary of Health, Education, and Welfare to publish an annual list ''of all known or potentially toxic substances and the concentrations at which such toxicity is known to occur,'' and to determine whether the levels of toxic substances present in individual workplaces posed a hazard to employees. It then would have prohibited employers from requiring employees to work in areas that had been determined to be hazardous without certain listed protections, ''unless such exposed employee may absent himself from such risk or harm for the period necessary to avoid such danger without loss of regular compensation for such period.'' See Lead, 647 F.2d at 1233.

In the first place, it is difficult to read significant congressional intent not to grant regulatory authority into the failure of the Congress to enact a provision in the Agency's enabling Act. See *U.S. Ex. Rel. Stinson* v. *Prudential Insurance,* 944 F.2d 1149, 1157 (3d. Cir. 1991); see generally 2A Sutherland Statutory Construction § 48.18. This is especially true when the provision is not identical to the regulation requirement at issue. And the Daniels Amendment has little in common with OSHA's WRP provisions. It would have provided the grounds for removal from work based upon informal action by the Secretary of Health, Education, and Welfare. WRP, however, results from OSHA rulemaking involving notice and comment procedures. See Lead, 647 F.2d at 1233. Further, WRP depends in large measure on a health care professional's determination that removal is appropriate, and the standard also contains a dispute resolution procedure to address disagreements among health care professionals. See Paragraph (s). More important, the Daniels Amendment would have allowed an employee to make an individual judgment that the grounds for removal applied; employees could thus effectively remove themselves from the workplace. Lead, 647 F.2d at 1233. Under WRP, however, removal occurs when certain criteria are met, and may even occur against an employee's will. See Paragraphs (e), (f), and (r). Because of these differences, the D.C. Circuit held in Lead that the Daniels Amendment ''would probably invite controversy and abuse in a way that [WRP] would not, so the reasons for which Congress rejected the [Daniels Amendment] may well not apply to [WRP].'' Lead, 647 F.2d at 1233–34.

Even so, NCE *et al.*argued that the Lead decision was incorrect because it misinterpreted a 1980 Supreme Court decision, *Whirlpool Corp.* v. *Marshall,* 445 U.S. 1 (1980). Ex. 500–197. OSHA is not convinced by this argument. The D.C. Circuit did not rely on the Whirlpool decision in holding that the Daniels Amendment violated congressional intent. Rather, the D.C. Circuit examined independently the language and history of the Daniels Amendment in reaching its conclusions. See Lead, 647 F.2d 1233–34 n.69. Although the court discussed Whirlpool, which it found consistent with its interpretation of the Daniels Amendment, its analysis did not rely on the Whirlpool decision. Id. Furthermore, the D.C. Circuit did not misread Whirlpool by noting the context of the Supreme Court's holding—that the Daniels Amendment would have allowed employees to unilaterally leave work at full pay under certain circumstances. Id.

Commenters also argued that WRP is barred by the Executive Order on Federalism (Executive Order), specifically sections 2(i) and 3(b). Ex. 30–3811, pp. 16–18. Section 2(i) of the Executive Order states that ''[t]he national government should be deferential to the States when taking action that affects the policymaking discretion of the States and should act only with the greatest caution where State or local governments have identified uncertainties regarding the constitutional or statutory authority of the national government.'' Section 3(b) provides that ''[n]ational action limiting policymaking discretion of the States shall be taken only where there is constitutional and statutory authority for the action and the national activity is appropriate in light of the presence of a problem of national significance. Where there are significant uncertainties as to whether national action is authorized or appropriate, agencies shall consult with appropriate State and local officials to determine whether Federal objectives can be attained by other means.'' 64 FR 43255 (Aug. 10, 1999). The Executive Order sets forth fundamental federalism principles, federalism policymaking criteria, and provides for consultation by federal agencies with state or local governments when policies are being formulated which potentially affects them. [Note: Section XIII of this preamble describes the Executive Order in more detail and discusses OSHA's interactions with State and local governments in the development of this rule. It also contains a certification by the Assistant Secretary that OSHA has complied with the applicable requirements of the Executive Order.]

WRP is not ''barred'' by the Executive Order. First, there is no ''uncertainty'' with respect to OSHA's authority to include WRP in this standard. As explained above, the OSH Act gives OSHA broad authority to include WRP where necessary or appropriate to effectuate its statutory mandate. Indeed, the rulemaking record requires OSHA to include WRP in this standard. Second, OSHA has found that ''national action'' is necessary to deal with the significant risk of MSDs in the workplace. As shown in great detail in the Risk Assessment and Significance of Risk sections, the problem of MSDs is national in scope. See Sections VI and VII below. Under these circumstances, a national standard to prevent MSDs is appropriate under the OSH Act and entirely consistent with the federalism policies set forth in the Executive Order.

Third and finally, OSHA consulted with stakeholders, including representatives from State and local governments, on WRP (and the standard in general). Numerous representatives from State and local governments testified at the hearing. See *e.g.,* 502–476 (Testimony of The Honorable Eliot Spitzer, New York State Attorney General; Testimony of National League of Cities). These same commenters and many others also submitted written comments on the proposed rule, including comments on WRP. See Section XIII for a larger discussion of the participation of State and local governments in the rulemaking proceedings. OSHA considered these comments in developing the final standard. OSHA also specifically sought comment from the public (including State and local governments) on whether the objectives of WRP could be attained by other non-regulatory means. 64 FR 65858 (Nov. 23, 1999). OSHA considered the various alternatives suggested; OSHA ultimately concluded, however, that those alternatives would be unable to accomplish the objectives of WRP (see Chapter VIII, Non-Regulatory Alternatives, of the Final Economic Analysis).

Finally, representatives of the insurance industry also argued that the McCarran-Ferguson Act prevents OSHA from including WRP in this standard. Ex. 30–3811, pp. 38–39. The McCarran-Ferguson Act states, in pertinent part: ''No Act of Congress shall be construed to invalidate, impair, or supersede any law enacted by any State for the purpose of regulating the business of insurance, or which imposes a fee or tax upon such business, unless such Act specifically relates to the business of insurance.'' 15 U.S.C. § 1012(b). Congress passed the McCarran-Ferguson Act in reaction to the Supreme Court's decision in *United States* v. *South-Eastern Underwriters Assn. (South-Eastern),* 322 U.S. 533 (1944). In South-Eastern, the Supreme Court held that ''insurance transactions were subject to federal regulation under the Commerce Clause, and that the antitrust laws, in particular, were applicable to them.'' *SEC* v. *National Securities, Inc.,* 393 U.S. 453, 457 (1969). The McCarran-Ferguson Act was an attempt to ''turn back the clock [to the time before the Supreme Court decision], to assure that the activities of insurance companies in dealing with their policyholders would remain subject to state regulation.'' Id. at 458–59.

The McCarran-Ferguson Act does not prevent OSHA from acting pursuant to its own authority under the OSH Act. OSHA derives its authority to issue standards from the OSH Act; OSHA is authorized to implement standards ''reasonably necessary or appropriate'' to accomplish its statutory goal. As explained in detail above, OSHA is operating well within its statutory authority by including WRP in this standard. The McCarran-Ferguson Act has no bearing on that authority. See *Women in City Government United et al.* v. *City of New York,* 515 F. Supp. 295, 303 (S.D.N.Y. 1981) (The McCarran-Ferguson Act was not intended to be applied ''indiscriminately to subsequent federal legislation * * * solely because legislation fails specifically to state that it is applicable in circumstances where insurance interests are implicated.'').

And, as explained more fully below in the discussion of section 4(b)(4) of the OSH Act, WRP will not invalidate, impair, or supersede any workers' compensation law or system. The operation of workers' compensation laws will remain unchanged after the standard is promulgated. WRP also will not supersede workers' compensation systems by encouraging or discouraging claims in those systems. The McCarran Ferguson Act does not prevent OSHA from issuing WRP.

2. Section 4(b)(4) Does Not Prohibit OSHA From Including WRP and Other Provisions in This Standard.

(a). *Section 4(b)(4) does not prohibit OSHA from including WRP in this standard.*

The most persistent criticism of WRP is that Section 4(b)(4) of the OSH Act forbids OSHA from imposing any type of wage continuation requirement. Section 4(b)(4) provides:

''Nothing in this Act shall be construed to supersede or in any manner affect any workmen's compensation law or to enlarge or diminish or affect in any other manner the common law or statutory rights, duties, or liabilities of employers and employees under any law with respect to injuries, diseases, or death of employees arising out of, or in the course of, employment.'' 29 U.S.C. 653(b)(4).

In the preamble to the proposed rule, OSHA explained in detail how the proposed WRP provision did not violate section 4(b)(4) of the OSH Act. Section 4(b)(4) of the OSH Act was intended to bar ''workers from asserting a private cause of action against employers under OSHA standards,'' and to prevent any party in an employee's claim under a workers' compensation law or other State law from asserting that an OSHA regulation or the OSH Act itself preempts any element of State law. *Lead,* 647 F.2d at 1235–36. In short, section 4(b)(4) prohibits OSHA from legally preempting state workers' compensation law. *Id.* Thus, even if WRP were to have a ''great practical effect'' on state workers' compensation systems, it would not violate section 4(b)(4) so long as it left the state scheme ''wholly intact as a legal matter.'' *Id.* at 1236 (emphasis in original).

The rulemaking record confirms that WRP in this standard will not change the legal scheme of state workers' compensation systems. Professor Emily Spieler, who is one of the nation's leading scholars on state workers' compensation systems and their interaction with other federal and state laws, submitted written comments and testified at great length on the effects of WRP on state workers' compensation systems. As noted above, Professor Spieler served as the Commissioner of the West Virginia Workers' Compensation Fund, responsible for setting insurance premium rates, premium collection from employers, initial claims review, and adjudication. She has lectured extensively on employment law and public health issues, and has authored and/or co-authored numerous articles on workers' compensation, see Ex. 37–14, Curriculum Vitae of Emily A. Spieler, including:

- Spieler E. Is Workers' Compensation the Only Legal Remedy for Workers Who Are Injured at Work? In Occupational Health: Recognition and Prevention of Work-Related Disease and Injury (4th ed. (Lippincott, Williams & Wilkins, Levy BS, Wegman, DW, eds., 2000).
- Spieler E. Dispute Resolution in Workers' Compensation Managed Care. Report prepared for Robert Wood Johnson funded project, A Guide to Evaluating the Effectiveness of Managed Care Programs in Workers' Compensation.
- Spieler E. Perpetuating Risk? Workers' Compensation and the Persistence of Occupational Injuries, 31 Houston Law Rev. 119–264 (1994).
- Spieler E. Injured Workers, Workers' Compensation, and Work, 95 W.Va. Law Rev. 333–467 (1992–93).

Professor Spieler stated that WRP would not alter or affect the legal scheme of state workers' compensation systems; nor would it ''supersede'' those systems. Specifically, she stated:

(1) WRP would in no way change the eligibility criteria for obtaining workers' compensation benefits in the state workers' compensation systems. In fact, she noted that the eligibility criteria for WRP and the eligibility criteria for state workers' compensation were substantially different.

(2) WRP would in no way change the filing requirements for state workers' compensation claims. Thus, an employee report of an MSD under the standard would not constitute the filing of a workers' compensation claim. Every state has its own procedures for filing workers' compensation claims; these would remain unchanged by WRP.

(3) WRP would in no way change the benefit payments paid through workers' compensation systems. Workers' compensation benefits are set by state statute; WRP would not affect the payment of those benefits.

(4) WRP would in no way change the review and adjudication process governing workers' compensation claims. ''Because of the no-fault principle of the workers' compensation program[], the level of hazard in the workplace and the general treatment of the injured worker is irrelevant to workers' compensation proceedings. In fact, OSHA rules have largely remained outside of workers' compensation discussions and proof. The existence of an ergonomics standard will not change that.''

(5) WRP would not cause an increase in workers' compensation premiums or change the calculation of workers' compensation premium rates.

Id. at 15–18; Ex. 500–140, pp. 1–2.

In summary, Professor Spieler stated that ''the proposed ergonomics standard [including WRP would] not interfere with, undermine, or federalize workers' compensation systems or illegally or inappropriately undermine the exclusivity doctrine.'' Id. at 18. See also Ex. 500–26 (Lynn Marie-Crider).

The Attorney General of New York State, Eliot Spitzer, echoed these same points with respect to the New York State workers' compensation system. General Spitzer stated that WRP would leave New York's workers' compensation system ''wholly intact as a legal matter.'' Ex. DC 75, p. 3. Specifically, WRP would not affect workers' compensation eligibility criteria in New York. Id. at 5. Neither would employers in New York State be effectively admitting liability under the state system by making certain determinations required by the standard, ''such as whether an employee has a covered MSD, whether that employee should be referred to a healthcare provider, or whether a WRP payment should be made.'' Id. at 6. General Spitzer also stated that WRP would not affect state workers' compensation laws by obstructing the states' return-to-work objectives. On the contrary, he stated that ''by encouraging early diagnosis and treatment of covered injuries * * * WRP would promote, not obstruct, rehabilitation and early return to work.'' Id. at 9. Finally, General Spitzer stated that WRP would not interfere with the exclusivity doctrine of workers' compensation: ''In my view there is no interference with these provisions because WRP is not providing remedies for injuries. Instead, by reducing the financial risks associated with reporting injuries, the income maintenance provisions of WRP would promote early reporting and treatment of the covered injuries and prompt adjustments in workplace conditions for similarly situated workers.'' Id. at 9–10. In making these observations, General Spitzer noted that similar WRP provisions in other OSHA standards have not interfered with the functioning of the New York State workers' compensation system. See Tr. 3385–3407.

Eighteen Attorneys General submitted post-hearing letters agreeing with the testimony of General Spitzer that WRP would leave state workers' compensation schemes wholly intact as a legal matter and not ''affect'' or ''supersede'' state systems in violation of section 4(b)(4). See Ex. 500–48.

There is also no record evidence to support the assertion that WRP will have a significant practical effect on state workers' compensation systems. Injured workers will still have numerous incentives to file for workers' compensation. First, neither WRP nor other provisions of the standard require employers to pay for or provide medical treatment. If a worker is injured on the job and requires medical treatment, that worker will need to file for workers' compensation. As noted by Professor Spieler, and consistent with the injury data described in Section VII, a large proportion of MSD claims in workers' compensation systems are for medical benefits only. Ex. 37–14, p. 16. Those individuals who are seeking only medical treatment through workers' compensation will not be affected by WRP. Second, WRP only requires employers to maintain 90% of a removed employee's gross earnings and benefits for up to 90 days. See Paragraph (r)(3). If a worker requires benefits for longer than that period of time, the worker will need to file for workers' compensation. Currently, 80% of workers' compensation indemnity benefits are for permanent disability. Id. Ex. 37–14, p. 16. Many of the workers receiving permanent disability benefits would not be eligible for WRP.

At the same time, OSHA does not expect that the number of workers' compensation claims will rise dramatically with WRP. As Professor Spieler stated in her written comments, ''the existence of the WRP provision is very unlikely to discourage—or encourage—the filing of workers' compensation claims.'' Id. This has been confirmed by earlier WRP provisions in other health standards where there has been no dramatic observable increase or decrease in the short run in the number of workers' compensation claims filed for conditions covered by WRP and state workers' compensation systems. See generally id. at 18; Ex. 500–218, p. 128.

For all of these reasons, WRP does not violate section 4(b)(4) of the OSH Act. Some commenters argued the opposite, however. Some argued that the language of section 4(b)(4) is unambiguous on its face: it precludes ''any interference [with State workers' compensation systems], whether of a legal, economic, public policy, practical or other kind.'' Ex. 30–3811, p. 14. These representatives also argued that the Lead decision was incorrectly decided; courts today, they argued, would interpret section 4(b)(4) differently. Id.; see also Ex. 32–22–1, pp. 34–35; Ex. 30–4467, p. 17. In addition, some commenters argued that numerous factual differences exist between WRP in this standard and WRP in the lead standard that make OSHA's reliance on the Lead decision misplaced. See Ex. 500–223, pp. 81–82; Ex. 30–4467, pp. 17–22. One important difference, according to these commenters, was that few employees under the lead standard would be eligible for both workers' compensation and WRP, whereas many employees under this standard will be eligible for both workers' compensation and WRP. See Ex. 500–223, pp. 84–85.

OSHA does not believe that section 4(b)(4) can be interpreted to prohibit OSHA from having any impact, either directly or indirectly, on state workers' compensation systems. Such an interpretation would prevent OSHA from enacting any occupational safety and health standard, for, as the court noted in Lead, ''any health standard that reduces the number of workers who become disabled will of course 'affect' and even 'supersede' worker's compensation by ensuring that those workers never seek or obtain work[ers'] compensation benefits.'' Lead, 647 F.2d at 1235. Congress obviously did not intend section 4(b)(4) to so limit OSHA's standard-setting authority. Instead, section 4(b)(4) is intended to prevent OSHA from affecting or superseding any state workers' compensation law; as the court noted in Lead, it is intended to ''bar[] workers from asserting a private cause of action against employers under OSHA standards,'' and to prevent a worker or employer from asserting in a state proceeding ''that any OSHA regulation or the OSH Act itself preempts any element of state law.'' Id. at 1236. OSHA has shown that WRP does neither.

Furthermore, there are not ''numerous'' factual differences between WRP in the lead standard and WRP in this standard. In fact, as explained above, there are a substantial number of similarities. To be sure, there may be a greater number of workers who qualify for WRP and state workers' compensation benefits under this standard than under the lead standard. Like the lead standard, however, these numbers will decline after the standard is in place. OSHA predicts that by encouraging early reporting, employees will report signs and symptoms of MSDs before they become disabling and compensable under state workers' compensation systems. Thus, the only ''effect'' of WRP will be that fewer employees will become disabled under state workers' compensation systems. As the court correctly noted in Lead, this is precisely the effect OSHA standards are intended to have. Lead, 647 F.2d at 1235.

Several commenters argued that WRP improperly ''supersedes'' the exclusive remedy provisions of state workers' compensation laws, essentially giving employees additional ''litigation rights'' before the Occupational Safety and Health Review Commission and the federal courts. Ex. 30–3811, pp. 19–22; see also Ex. 32–22–1, pp. 11–12.

Workers' compensation systems were initially designed to provide the sole remedy for injuries and illnesses covered by the systems. Of primary importance was that employees would no longer be permitted to assert a negligence claim against employers for injuries arising out of and in the course of employment. Ex. 37–14, p. 12 (Spieler). ''Notably, workers' compensation continues to bar alternative tort-based legal actions against employers that involve negligently caused physical injuries arising out of and in the course of employment.'' Id. This has been termed the ''exclusivity'' doctrine.

As explained by Professor Spieler, however, a number of federal and state laws have expanded the rights of injured workers.

''[A] wide variety of legal rights have developed since workers' compensation laws were initially passed. These include federal employment-based laws (such as OSHA, the Americans with Disabilities Act, the Family Medical Leave Act) that provide additional rights to people with work-related health conditions; state employment-based laws (such as anti-retaliation rights under the public policy exception to the at-will employment doctrine and disability discrimination laws); state common law torts that provide remedies for employer actions other than the specific negligence that caused the injury (such as fraud); and, in a growing minority of states, some expansion of the definition of intentional actions that remove injuries from the state exclusivity provisions. All of these legal developments represent an expansion of workers' rights when they are injured at work. *Id.*

Thus, while the ''exclusivity'' doctrine still exists in workers' compensation, it exists within the broader framework of other Federal and State rights granted workers by Congress and state legislatures. These rights have not been held to violate or contradict in any way the exclusivity doctrine of state workers' compensation systems; ''[t]hey do not change the exclusive nature of workers' compensation for the specific purpose of shielding employers from common law tort actions based on negligence.'' *Id.*

Neither does WRP. WRP provides employees some wage protection in order to encourage them to report signs and symptoms of MSDs early. ''WRP does not create any common law tort remedy for [an] occupational injury.'' Ex. 500–140, p. 2 (Spieler). WRP does not give employees any additional procedural or substantive legal rights; WRP places a requirement on employers to provide some wage protection to employees when they are placed on temporary work restrictions. WRP does not give employees a right to file a cause of action against an employer for WRP benefits; WRP does not give an employee the right to file a cause of action against an employer for failure to pay WRP. To be sure, the OSH Act confers some procedural rights upon employees and/or their designated representatives to participate in OSHA enforcement proceedings; however, these rights were given employees by Congress and are very limited. Indeed, employees may only question the Secretary of Labor's exercise of prosecutorial discretion in an enforcement case before the Occupational Safety and Health Review Commission on the issue of abatement dates in a citation. 29 U.S.C. 659. WRP does not violate the exclusivity doctrine of state workers' compensation systems.

WRP also does not conflict with, or frustrate the return-to-work policies of state workers' compensation systems. Ex. 30–3811, pp. 22–24; Ex. 32–22–1, pp. 16–18. Most state workers' compensation systems provide temporary total disability (TTD) benefits to injured workers in the amount of 66 2/3rds of their average weekly wage. These payments are not taxed. Dr. Leslie Boden testified at the informal public hearing that OSHA's proposed WRP provision was approximately equal to the amount of TTD benefits provided in state workers' compensation systems. *See* Ex. DC–47. The vast majority of workers who receive WRP because they are removed entirely from work, therefore, will receive approximately the same amount of money with WRP as they would under most state workers' compensation systems. Because WRP and TTD benefits are approximately equal, WRP is no more repugnant to the ''return-to-work'' philosophy than are state workers' compensation systems.

Even so, many injured workers currently receive supplemental payments above and beyond workers' compensation. Some states specifically authorize such a practice. According to Lynn-Marie Crider, a former member of the Oregon Workers' Compensation Board and an expert in workers' compensation:

''[T]here is nothing in any workers' compensation system with which I am familiar that forbids workers from receiving greater wage replacement payments than are provided for by the workers' compensation system. Workers may receive supplementary payments from the employer by tapping sick leave benefits, under a disability insurance plan, and so forth. These additional payments are specifically authorized by Oregon law. ORS 656.118. So, at least in this state, it would be impossible to argue * * * that any additional payments that a worker might receive under the WRP provisions of the proposed rule violate an expectation that a worker will receive no more than the maximum benefit amount established for temporary disability compensation.'' Ex. 500–26, p. 4.

OSHA is unaware of any commenter who has argued that these supplemental benefits are repugnant to the ''return-to-work'' philosophy of workers' compensation.

Furthermore, current data indicates that 82% of workers with MSDs are returned productively to work by HCPs and only 3% are removed entirely from the workplace. *See* Ex. 500–118. By encouraging employees to report signs or symptoms of MSDs early, OSHA believes that even fewer workers will need to be removed entirely from work. In this respect, this standard (including WRP) actually promotes the ''return-to-work'' philosophy.

Finally, the record does not show that ''return-to-work'' is a basic philosophy of workers' compensation. While many representatives of the insurance industry aggressively argued that it is, Professor Spieler had a contrary observation:

''[I]t is important to note that it is simply incorrect to say that 'return-to-work' is one of the 'foundational concepts of workers' compensation law.' Until the last 25 years, there was absolutely no evidence that return-to-work was a basic component of the workers' compensation world. Workers who collected benefits under the workers' compensation systems had no right to return to work; employers had no obligation to return them to work; and in many cases workers who collected benefits were simply terminated from employment. Recent judicial and legislative developments, combined with an expanded understanding that aggressive return-to-work efforts can increase productivity and decrease workers' compensation costs, has led to a change in the way that this issue is discussed in workers' compensation circles.'' Ex. 500–140, p. 3 (internal citations omitted).

Commenters also argued that WRP ''supersedes'' state workers' compensation systems by eliminating injury requirements and lessening causation requirements. *See* Ex. 30–3811, pp. 24–28; Ex. 32–22–1, pp. 12–13.

WRP will not directly change, alter, affect, or eliminate the injury requirements or causation requirements of any state workers' compensation law. States will continue to operate their systems in the manner they deem appropriate. WRP will also not indirectly coerce states to change or alter their injury and causation requirements. As stated by Professor Spieler, ''[t]here is no logic to the claim that WRP would force complete revision of state workers' compensation laws. Workers' compensation [will] continue to process claims exactly as they have always done.'' Ex. 500–140, p. 3. Furthermore, the fact that WRP imposes (or does not impose) certain requirements on employers that are different from workers' compensation in certain ways does not mean that WRP ''supersedes'' such systems. In the words of Professor Spieler, these differences ''underscore the fact that WRP leaves workers' compensation unaffected.'' *Id.*

For the same reasons, OSHA also disagrees with those commenters who argued that WRP would ''supersede'' state standards in workers' compensation for determining the amount of compensation. See Ex. 30–3811, p. 29–33. WRP will not change, alter, or eliminate those state standards. The mere fact that WRP has a ''different'' benefit level and does not contain maximum or minimum levels does not mean that it ''supersedes'' or ''affects'' state workers' compensation systems; as explained above, it means just the opposite.

Some commenters argued that WRP would drastically increase the number of state workers' compensation claims, thus ''affecting'' state systems in violation of section 4(b)(4). See *e.g.*, Tr. 9786 (Nelson). Other commenters, however, argued just the opposite: because WRP provides ''greater benefits'' to injured workers, workers will not file workers' compensation claims, thus ''affecting'' state workers' compensation in violation of section 4(b)(4). See *e.g.*, Ex. 30–4467, pp. 19–20.

OSHA has addressed this issue in great detail above. OSHA does not believe that claims for workers' compensation will increase dramatically after the standard is promulgated; past experience with other standards that include WRP supports this. See Ex. DC–75, p. 11. On the other hand, OSHA does not believe that injured or disabled workers will stop filing valid workers' compensation claims. See id. at 11–12. In order to receive medical benefits or benefits after 90 days, employees will need to file for workers' compensation. As stated by Professor Spieler, ''the existence of the WRP provision is very unlikely to discourage—or encourage—the filing of workers' compensation claims.'' Ex. 37–14, p. 16.

Some commenters argued that WRP ''affects'' or ''supersedes'' state workers' compensation systems by providing for double recovery for injured workers. See *e.g.*, Ex. 32–22–1, p. 19–20. These commenters specifically argued that state systems do not permit the attachment of state workers' compensation payments; thus employers would have no mechanism for retrieving from employees payments made pursuant to WRP. Id.

As explained more fully below, WRP does not provide for double recovery for injured workers. WRP includes a provision which allows employers to reduce their WRP payments when an employee receives payments from workers' compensation. It is immaterial in this respect whether states permit or prohibit attachment of workers' compensation payments. WRP does not speak to the issue of attachment of these payments. Rather, WRP permits employers to reduce their WRP payments by the amount received by the employee from other sources. This prevents an employee from receiving ''double recovery.'' See also Discussion of offset provision below.

Some commenters argued that WRP violates section 4(b)(4) because it creates a conflict of interest between employers and insurance carriers. See *e.g.*, Tr. 6472–73 (McGowen).

OSHA is not convinced that WRP will create a conflict of interest between insurance companies and employers. Both employers and their insurance carriers have a common interest: reducing injuries and illnesses at work. Reducing the incidence of MSDs will reduce WRP payments as well as workers' compensation costs. OSHA believes that both employers and insurance carriers currently share this goal and will continue to share this goal after the standard is promulgated.

Even if the standard did introduce some conflict between insurance carriers and employers with respect to any particular workers' compensation claim, however, OSHA does not believe this violates section 4(b)(4). Once again, section 4(b)(4) prohibits OSHA from preempting, in whole or in part, the legal scheme of state workers' compensation systems; any potential conflict of interest does not directly or indirectly affect the legal scheme of any state system.

Two commenters suggested WRP violates section 4(b)(4) because it will (1) Result in ''blatant forum shopping by employees and their representatives,'' (2) serve as ''res judicata'' or ''collateral estoppel'' in a later state workers'' compensation proceeding, (3) create incentives for state administrators to encourage employees to ''file'' for WRP and not file a state workers'' compensation claim, and (4) create disincentives for states to cover MSDs. See Exs. 32–300–1, pp. 12–13; 30–3853, pp. 27–28.

First, OSHA does not understand how WRP, a uniform federal requirement, would encourage ''blatant forum shopping'' by employees. As shown, state requirements for filing of workers' compensation claims will remain unchanged after the standard is promulgated. WRP would not give employees any additional rights to file for workers' compensation claims in other forums or allow employees to choose in which forums to file workers' compensation claims.

Second, WRP will not serve as ''res judicata'' or ''collateral estoppel,'' or otherwise be improperly used in any state workers'' compensation proceeding. The Attorney General of New York State addressed this issue in his testimony at the informal public hearing:

> ''[E]mployers would not effectively admit liability under state workers' compensation laws by making certain determinations required by the WRP such as whether an employee has a covered MSD, whether that employee should be referred to a health care provider, or whether a WRP payment should be made. None of these determinations would constitute an admission of liability under New York's Workers' Compensation scheme.'' Ex. DC75, pp. 6–7; see also Ex. 37–14, p. 16.

Indeed, Professor Spieler stated in her written testimony that in the past OSHA rules ''have largely remained outside of workers' compensation discussions and proof.'' Ex. 37–14, p. 16. This, of course, makes sense given that the no-fault principle of workers' compensation makes ''the level of the hazard in the workplace and the general treatment of the injured worker'' irrelevant to the state proceeding. *Id.*

Third, OSHA does not anticipate that inclusion of WRP in the standard will provide an incentive for state administrators to encourage workers to ''file'' for WRP instead of for workers' compensation benefits. It is important to reiterate that workers do not file for WRP, as they do under state workers' compensation systems. Employers (and in certain circumstances HCPs) make the determination of whether work restrictions are necessary and thus whether WRP is appropriate; this determination is not made through an employee ''filing.'' State administrators thus could not encourage workers to file for WRP. Furthermore, employees have an independent incentive to file for workers' compensation, an incentive unaffected by the actions of state administrators—WRP does not pay for medical treatment, or for any benefits after 90 days. And finally, these commenters did not explain how state administrators could actually encourage individual workers to file for WRP. While it is true that in most state systems workers' compensation administrators become involved at certain stages of claims proceedings, the determination of whether to initiate a workers' compensation claim is typically made at the plant level, where the injury occurred.

Fourth, WRP will not discourage—or encourage for that matter—states from covering MSDs. As Professor Spieler stated, ''[t]here is no logic to the claim that WRP would force complete revision of state workers' compensation laws.'' Ex. 500–140, p.3. The decision by a particular state system as to whether a certain injury or illness should be covered is a decision made appropriately by state legislatures after consideration of a number of factors.

Inclusion of WRP in this standard will not independently affect this decisionmaking process.

Some commenters argued that the standard violates section 4(b)(4) by denying employees and employers due process in making a claim for WRP under the standard. See *e.g.*, Ex. 32–22–1, pp. 14–16.

Once again, employees do not make a ''claim'' for WRP under this standard. In this respect, WRP is fundamentally different from workers' compensation. Under this standard, employers make the determination as to whether work restrictions are appropriate; if they are, employers must provide WRP. If an employer is cited for failing to provide WRP, the OSH Act provides an opportunity for the employer to contest the citation. Employers are thus not denied due process with respect to WRP.

That said, OSHA has included a dispute resolution mechanism in the final standard that was not included in the proposed rule in order to address concerns raised both by employer and employee groups. See Paragraph (s). Many commenters from both labor and industry asked OSHA to include some dispute resolution mechanism in the standard so that employers and employees could more efficiently handle disputes related to work restrictions. See *e.g.*, Exs. 500–218, p. 124; 32–300–1, p. 30; Tr. 7654. OSHA has responded to these comments and included such a mechanism in the final standard. See Discussion below. OSHA notes, however, that it is not aware of any employee group that alleged that the proposed standard violated constitutional due process by failing to have a dispute resolution mechanism in the proposed standard for appealing various employer determinations.

Some commenters argued that the standard violates section 4(b)(4) because it does not permit employers to stop paying WRP if it is determined that a worker is engaging in practices that delay or prevent his/her recovery. See *e.g.*, Ex. 32–22–1, p. 26.

OSHA believes that these commenters misunderstood the proposed rule; OSHA has attempted in this rule to clarify the discussion of MSD Management with respect to employer obligations to provide WRP. This standard expressly provides that employers may condition the payment of WRP on employee participation in MSD management. This includes the evaluation and follow-up of employees. Thus, an employer may stop WRP payments if an employee is not participating in the evaluation and follow-up provided for by MSD Management. See Paragraph (r)(4).

Commenters argued in general that because WRP is different from state workers' compensation systems (*i.e.*, different standards, different burdens of proof, different compensation rates, different dates, the presence of a waiting period, etc.), it creates a parallel benefits scheme in violation of section 4(b)(4). See Ex. 32–22–1, pp. 12–18; Tr. 6466 (McGowen).

As OSHA explained above, the fact that differences exist between WRP and state workers' compensation systems demonstrates that WRP does not violate section 4(b)(4). WRP is a federal requirement separate from the requirements and procedures of state workers' compensation systems. It is not intended to replace workers' compensation. It is designed instead to accomplish very different purposes. Workers' compensation is designed to compensate workers after an injury has occurred. WRP is designed to encourage employees to report signs or symptoms of MSDs early, before they become severe and disabling, and to cooperate with the standard's MSD management provisions. As such, it is not surprising that WRP and state workers' compensation systems have different schemes, etc. The fact that WRP operates differently from state workers' compensation systems does not mean that it ''supersedes'' or in any manner ''affects'' workers' compensation. In the words of Professor Emily Spieler:

> ''All of the differences * * * between WRP and workers' compensation underscore the fact that WRP leaves workers' compensation unaffected. This includes the different process of selection of the evaluating health care provider (HCP); the different role of the HCP; the different enforcement mechanisms; the different standards for evaluation of whether the MSD is covered; the differences in burdens of proof; and any differences in payment levels. The very fact that there will be inconsistent outcomes * * * suggests that WRP will not affect state workers' compensation programs.'' Ex. 500–140, p. 3.

See also Ex. 500–26, pp. 3–4.

One commenter, Robert Aurbach, General Counsel of the New Mexico Workers' Compensation Administration, in his capacity as a private citizen argued that WRP violates the second clause of section 4(b)(4) by (1) Providing different requirements for HCP choice, (2) eliminating waiting periods, (3) shifting the burden of proof, (4) requiring employers to ''fix'' problem jobs, (5) requiring payment for medical care, (6) creating conflicts of interest between employer and insurance carriers, (7) creating additional administrative burdens, and (8) being, in general, overbroad. Ex. 32–22–1, pp. 27–31.

OSHA has addressed some of Mr. Aurbach's specific points above. WRP and other provisions of the standard do not require employers to pay for medical care, do not create conflicts of interest between employers and insurance carriers, and do not affect state workers' compensation waiting periods or burdens of proof. OSHA also does not believe that this standard is overbroad—OSHA has carefully tailored this standard to address exposure to ergonomic risk factors at levels shown to cause a significant risk of MSDs.

OSHA admits that the standard will place certain requirements upon employers to ''fix'' problem jobs, and keep some records of their ergonomics programs. Imposing these requirements on employers, however, does not violate section 4(b)(4). Virtually every OSHA standard includes some new requirements or places some administrative burdens on employers. This is not surprising given that the scheme of the statute, manifest in both the express language and the legislative history * * * [permits] OSHA to charge to employers the cost of any new means it devises to protect workers.'' Lead, 647 F.2d at 1230–31. For example, OSHA has required employers to install local exhaust ventilation in numerous health standards, produce and keep medical surveillance records of employees, provide hazard information to employees, etc. These requirements have never been held to violate section 4(b)(4). Indeed, if Mr. Aurbach's interpretation of the second clause of section 4(b)(4) were accurate, section 4(b)(4) would prevent OSHA from issuing any occupational safety and health standard. Under Mr. Aurbach's interpretation of the second clause of section 4(b)(4), if OSHA places any burdens (such as administrative burdens or the requirement to eliminate hazards in dangerous jobs) on employers not already required either by statute or the common law, section 4(b)(4) is violated. This interpretation is not plausible.

Contrary to Mr. Aurbach's assertion, the second clause of section 4(b)(4) must be read in conjunction with the first clause discussed in detail above. Section 4(b)(4) as a whole prevents OSHA from displacing or preempting the legal scheme of state workers' compensation. WRP will do no such thing. Section 4(b)(4) cannot be read to prevent OSHA from issuing safety and health standards.

(b). Section 4(b)(4) does not prohibit OSHA from including certain other provisions in this standard, as some commenters argued.

Several commenters argued that the confidentiality provision (Paragraph (p)(2)) of the standard ''supersedes'' state workers' compensation systems because such systems permit the employer to obtain any information from an HCP related to a workers' compensation claim. See *e.g.,* Ex. 32–22–1, pp. 25–26.

OSHA admits that the confidentiality provision in the proposal was not clear. OSHA has changed the language in the final rule to clarify it. As explained in more detail above, if a state workers' compensation system requires or even allows employers to obtain information related to a workers' compensation claim, the MSD management provisions would not prevent that information from being passed from the HCP to the employer in any manner. OSHA thus does not ''supersede'' or ''affect'' the different mechanisms provided by the states for the employer to obtain information from an HCP about a workers' compensation claim.

Commenters also argued that the standard ''supersedes'' state workers' compensation systems because (1) it allows the employer to select the initial HCP (whereas in numerous states the employee can select the initial HCP) and (2) it permits certain HCPs to participate in MSD management, even though those HCPs would not be qualified under state law to examine state workers' compensation claimants. See *e.g.,* Ex. 30–3811, pp. 34–37; Ex. 32–22–1, pp. 20–26.

This standard does not require employers to select the initial HCP. As explained above, this standard requires employers to make an HCP available to injured employees. Employers may choose to satisfy this requirement by operating within the selection practices of their state workers' compensation systems. (In fact, OSHA anticipates that most employers will do this.) Thus, if a state permits an employee to choose the initial HCP, that practice could continue under this standard.

Furthermore, the fact that OSHA is permitting certain HCPs to participate in MSD management who may not be permitted to examine workers' compensation claimants under state workers' compensation systems does not violate section 4(b)(4). OSHA has determined, based upon the rulemaking record, that certain ''HCPs,'' operating within their scope of practice, can perform certain functions under MSD Management. This is an appropriate exercise of OSHA's authority and one that OSHA has exercised in other standards. See 29 CFR 1910.1052(b) (Methylene Chloride). OSHA is not changing the state requirements for practice of HCPs under workers' compensation laws. Those requirements remain the same.

Commenters argued in general that the standard ''supersedes'' state workers' compensation systems because it establishes separate requirements for the provision of medical care with different cost structures, treatment guidelines, and regulatory burdens. See *e.g.,* Ex. 30–3811, pp. 34–38.

This standard does not require the employer to pay for or provide medical care and/or treatment. MSD management only requires employers to make an HCP available for evaluation and follow-up. The standard does not establish any cost structures or treatment guidelines, etc. Indeed, OSHA has expressly declined to include such requirements in the standard. See Discussion of MSD management above.

Finally, many commenters argued that WRP (and other provisions of the standard) improperly (1) creates a ''most-favored injury'' by providing compensation for MSDs at a higher rate than for other occupational injuries and illnesses, and (2) treats employers and employees in different states with different compensation systems differently. See *e.g.,* Tr. 6435–36 (Ewing); 6457 (Situkiendorf).

WRP does not result in workers with MSDs being compensated at a higher level than workers with other injuries and illnesses. As stated above, WRP payments are approximately equal to the amount of TTD payments received by workers through workers' compensation for all occupational injuries and illnesses. The standard also includes an offset provision that prevents an employee from receiving both WRP and workers' compensation. See Discussion of offset provision below. OSHA is thus not creating a separate class of injured workers and paying them at a higher rate than injured workers receive under workers' compensation.

OSHA has acted pursuant to its statutory authority to issue this standard to reduce the significant risk of employees developing MSDs from workplace exposure to ergonomic risk factors. The rulemaking record requires that OSHA include WRP to effectuate the purposes of this standard. WRP is designed to encourage employees to report MSDs early and to participate in MSD Management; it is not designed to, nor will it, compensate injured workers at a higher level than injured workers receive under state workers' compensation. Simply because OSHA has singled out certain injuries and illnesses for regulation, but not others, does not mean that OSHA has acted improperly. OSHA's inclusion of WRP in other standards has never been ruled ''improper'' because it somehow created a ''most-favored injury.''

Furthermore, OSHA disputes that by creating a uniform federal requirement it is treating employers and employees differently in the various states. On the contrary, WRP applies equally to employers and employees in general industry. If, for example, two workers from different states must be removed from work due to the same MSD, they both will receive at least 90% of their gross earnings and benefits for up to 90 days. WRP creates no inequality.

To be sure, inequity currently exists in state workers' compensation systems. But as Professor Spieler stated in her written comments on the proposed rule, WRP will not introduce, solve, or affect that inequity:

> ''One final and important point: Some have argued that the proposed standard introduces inequity or inequality into the treatment of workers with occupationally-related MSDs. * * * But the proposed standard does not introduce inequity or inequality into the programs that provide protection for the affected workers. Serious inequities exist already. Currently, eligibility criteria for MSDs and payment levels in workers' compensation programs vary wildly from one state jurisdiction to another. So do protections under state-mandated temporary disability programs and under state disability rights laws. Some workers will receive medical treatment, permanent disability benefits, vocational training, and job placement; others, with equivalent MSDs will not. Irrespective of the promulgation of the proposed standard, these inequities will persist. They will persist precisely because state workers' compensation programs will be unaffected by the promulgation of the standard.'' Ex. 37–14, p. 19.

3. Section 4(b)(1) Does Not Prevent OSHA From Applying WRP to Federal Employees.

The United States Postal Service, as well as certain federal agencies, argued that section 4(b)(1) of the OSH Act prevents OSHA from applying WRP to federal employees because the Federal Employees Compensation Act (FECA) occupies the field with respect to compensation for work-related injuries. Ex. 35–106–1, pp. 14–21.

FECA provides compensation to federal employees injured while in the performance of their duties. 5 U.S.C. 8102. For totally disabled individuals, FECA pays 66 2/3% of their monthly pay. 5 U.S.C. 8105(a). In this respect, FECA is similar to state workers' compensation systems. FECA also has certain maximum and minimum levels for compensation, as well as a three day waiting period. Unlike various state systems, however, FECA contains a continuation of pay mechanism (COP) for employees who suffer traumatic injuries. Under COP, employees may receive a continuation of their pay ''without a break in time'' for up to 45 days. 5 U.S.C. 8118. Furthermore, the FECA provides that ''[a]n employee may use annual or sick leave to his credit at the time the disability begins.'' 5 U.S.C. 8118(c). Like state workers' compensation systems, FECA was enacted to provide federal employees with a quicker and more certain recovery for work-related injuries.

FECA does not preempt OSHA under section 4(b)(1) of the OSH Act from applying WRP to federal employees. Section 4(b)(1) of the OSH Act provides, in pertinent part:

> Nothing in this Act shall apply to working conditions of employees with respect to which other Federal agencies * * * exercise statutory authority to prescribe or enforce standards or regulations affecting occupational safety or health. 29 U.S.C. 653(b)(1).

Section 4(b)(1) ousts OSHA from jurisdiction over working conditions over which another agency has exercised statutory authority. At the time the OSH Act was passed various federal agencies had statutory authority to prescribe and enforce standards and regulations affecting occupational safety and health. To avoid duplication of effort, Congress included section 4(b)(1) in the OSH Act. Thus, section 4(b)(1)'s broad purpose is to avoid duplicative regulatory burdens without impairing the OSH Act's primary goal of ''assur[ing] so far as possible every working man and woman in the Nation safe and healthful working conditions.'' 29 U.S.C. 651(2)(b).

In order for an agency's action to preempt OSHA under section 4(b)(1), the agency must formally ''exercise'' its statutory authority to regulate ''particular working conditions,'' or express its view that no action should occur. See *e.g., Baltimore & Ohio R.R.* v. *OSHRC,* 548 F.2d 1052, 1053–55 (D.C. Cir. 1976); *Southern Pacific Transp. Co.* v. *Usery,* 539 F.2d 386, 390–92 (5th Cir. 1976), cert. denied, 434 U.S. 874 (1977). While courts differ slightly in their interpretation of what constitutes ''working conditions'' for purposes of section 4(b)(1), all approaches are based on the Supreme Court's definition of that term as limited to an employee's ''surroundings'' and the '' 'hazards''' incident to his work.'' Southern Pacific Transp., 539 F.2d at 390 (quoting and citing *Corning Glass Works* v. *Brennan,* 417 U.S. 188, 202 (1974)). Thus, the courts examine whether the other agency's exercise of authority is directed to the ''particular'' or ''identical'' working condition that causes the injury or illness that is addressed by the OSHA standard at issue. In re Inspection of Norfolk Dredging Co., 783 F.2d 1526, 1530–31 (11th Cir.), cert. denied, 479 U.S. 883 (1986).

In this case, FECA is not directed at all to the working conditions addressed by this standard. This standard requires employers to implement an ergonomics program to reduce exposures to ergonomic risk factors in the workplace. It adopts a comprehensive approach to reducing the significant risk of MSDs. One critical aspect of that approach is MSD management and WRP. By encouraging workers to report signs or symptoms of MSDs early (even before they become recordable or compensable), WRP prevents serious injuries from occurring. It also alerts employers to the presence of risk factors in a particular job.

FECA, one the other hand, does not attempt to regulate ergonomic hazards in the workplace to prevent MSDs from occurring in the first instance (*i.e.,* regulate ''working conditions'' that cause the injury or illness). In fact, it is not concerned with targeting and reducing occupational hazards at all. FECA is a statute that compensates workers after injury occurs. As such, it has a wholly separate purpose from WRP (and, indeed, this standard as a whole). To be sure, FECA may indirectly ''affect'' the occupational safety and health of workers by providing compensation after injury and encouraging temporary work restrictions; however, it is not targeted to the working conditions that cause MSDs. WRP is not preempted by FECA under section 4(b)(1) of the OSH Act.

C. Other Considerations

1. Non-monetary alternatives

Several commenters argued that non-monetary alternatives can be effective in increasing reporting of MSDs by employees and are preferable to WRP (Exs. 30–4467, p. 23; 32–300–1, p. 24). The EEI wrote:

> EEI does not believe that OSHA has sufficiently proven that WRP is the only effective method to ensure accurate reporting. OSHA acknowledges that a properly designed incentive plan can be successful. OSHA reports that a number of stakeholders have said that employers use various non-monetary incentives to achieve a safer and more healthful workplace. Some of these incentives include recognition and nominal rewards (company caps, plaques) for reporting hazards or presenting ideas to fix problem jobs or reduce severity rates. These types of incentives can and do increase employee reporting.

Ex. 32–300–1, p. 24.

OSHA concludes that there are major drawbacks to relying upon non-monetary alternatives to increase employee reporting and participation in ergonomics programs. As EEI noted, one type of non-monetary alternative involves recognition and nominal rewards for reporting hazards or presenting useful ideas to improve safety. Although OSHA solicited comment on the issue, there was no consensus even among employers that this type of non-monetary incentives is an effective substitute for wage protection policies in motivating employees to report. While there is some evidence non-monetary inducements to reporting hazards can be effective as part of a well designed safety and health program, such programs may also involve full or partial wage protection, sick leave, or disability benefits if employees must lose time from work. While many employers have generous benefits policies that would enhance the effectiveness of non-monetary incentives, many do not (64 FR 65852). Absent persuasive evidence that non-monetary incentives for reporting hazards, standing alone, can achieve increased reporting, OSHA sees no basis to rely on them to the exclusion of WRP.

Another type of incentive plan rewards employees with prizes for reporting low numbers of injuries or no injuries. As the preamble discussion of Paragraph (h)(3) makes clear, incentive plans of this type can effectively deter reporting because employees may value the prize more than any health or safety benefit that reporting would produce. See, *e.g.,* Tr. 15453, 10992, 7703). Moreover, in plans that reward teams of employees for low rates of reported injuries, peer pressure exerted by the group can be an effective deterrent to reporting by team members (Tr. 15453, 11638).

For these reasons, OSHA finds that non-monetary incentives would not be as effective as WRP in encouraging employees to report MSDs.

2. Duration and Level of Benefits

(a). Maximum duration. The proposed rule established a maximum duration of 6 months for each episode of WRP benefits. Several commenters supported the agency's preliminary determination that benefits should be provided for up to six months if necessary (see *e.g.,* Exs. 500–218, p. 131; 32–185–3, p. 11–10). Other commenters argued that a six-month duration is unnecessarily long in light of the data showing that most MSD cases will recover in far less time (Exs. 30–352; 32–300–1; 30-3344). The EEI

recommended reducing the maximum duration period to 3 months:

Even if OSHA chooses to maintain a WRP provision, it has not shown sufficient justification for six months of coverage. OSHA claims that early recognition, diagnosis and treatment interventions will lead to speedier recoveries from MSDs. Given this premise, the six-month WRP period of time is inordinately long and may enhance the tendency for an employee with a mild MSD case to malinger. OSHA recognizes within the [proposed rule's] preamble a median length of disability for all MSDs of 99 days with many of these cases resolving in significantly less time. Reducing the WRP to three months would be consistent with the anticipated benefits of the proposed rule and will reduce the cost and complexity of the program to employers.

Ex. 32–300–1, p. 23.

OSHA preliminarily estimated that while most employees with lost-work-time MSDs would recover within 3 months, over 12% of all lost workday cases involved more than 3 months away from work, and that for some types of serious MSDs, the typical disability duration was more than 3 months (64 FR 65855). OSHA concluded that a six-month maximum time for WRP was reasonable because it would allow the majority of workers with more serious MSDs time to recover before losing their benefits. Id.

In the final rule, OSHA has revised its estimates of the number of days employees will be out of work due to MSDs. The agency now estimates that 90% of all workers who experience lost work-time MSDs will return to work within 3 months. In addition, OSHA estimates that in approximately 70% of cases in which workers' compensation claims for MSDs are filed, benefits will be available to replace up to two-thirds of the employee's lost wages. See OSHA's Final Economic Analysis. While a high percentage of workers with MSDs do not currently file claims for workers' compensation benefits, OSHA expects this rate of under-filing to decrease with the implementation of WRP, particularly in cases in which the recovery period exceeds three months. Employees will have an incentive to pursue benefits since claims-filing will not threaten immediate economic harm, and may be the only avenue to recovery of medical expenses and extended wage loss. See Emily Spieler, Ex. 37–14, pp. 18–19, and Tr. 3353. Employers will also have a greater incentive to encourage employees to file claims, or to initiate claims themselves in the majority of states that permit employer-filed claims, because the final rule permits an offset against WRP for workers' compensation benefits received by employees. Thus, of the relatively few workers who will require more than 3 months to recover from their MSDs, a substantial number will be eligible for workers' compensation benefits to replace a portion of lost income and to pay for medical expenses.

For these reasons, OSHA concludes that a three month maximum time period for WRP is appropriate. Based on the estimates discussed above, OSHA believes that the vast majority of workers with lost-time MSDs will receive, or be eligible to receive, a substantial portion of their wages while recovering. OSHA acknowledges that there will be some workers who will require more than three months to recover, and who will not receive workers' compensation or other benefits after the first three months. However, OSHA estimates that this group will represent a small proportion of all workers with lost-time MSDs.

The Agency does not believe it is appropriate to structure WRP requirements around this small group of employees. WRP is intended to provide temporary benefits to encourage employees to report MSDs and to participate in MSD management. As discussed at length in Section B above, WRP is not intended as a federal remedy for workers who have suffered work-related MSDs, or as a supplement to state workers' compensation systems. Based on the record, OSHA believes that a requirement to provide WRP for up to 3 months will be effective in substantially increasing the number of employees reporting MSDs and their signs or symptoms. While requiring WRP for up to 6 months or longer would provide a greater degree of economic protection to injured workers, it would likely produce little if any additional improvement in reporting. As OSHA noted in the proposal, the available data indicate that overall, the number of workers out of work for less than 6 months is not significantly greater than the number of workers out of work for less than 3 months (64 FR 65855).

In the proposal, OSHA considered several alternatives that would have reduced the maximum duration of MRP benefits to substantially less than 90 calendar days. OSHA preliminarily concluded that limiting MRP benefits to no more than seven days would not provide the requisite protection to employees to encourage them to report MSDs early and to participate in MSD management. 64 FR 65856. The agency noted that employees whose injuries do not resolve within the WRP coverage period would have to rely on workers compensation, and that the effect of the waiting periods required by state systems could be that some of these employees would have no protection for several days. Id. In addition, employees who require more than seven days to recover, but who are not covered by workers' compensation, would face substantial financial pressure to return to work early. For these reasons, OSHA preliminarily concluded that this alternative would have a chilling effect on early reporting. Id.

OSHA solicited comment on whether the alternatives outlined in the proposal, or other alternatives would effectively encourage early reporting and participation. 64 FR 65858. The agency received no evidence that providing WRP for less than 90 calendar days would achieve this purpose. Accordingly, the final rule requires that WRP be provided for up to 90 calendar days.

(b). Interim cutoff points. The final rule permits employers to terminate WRP benefits before the expiration of the 90 calendar day maximum period if one of the following occurs: (i) the employee is able to resume the former work activities without endangering his or her recovery, or (ii) an HCP determines, subject to the dispute resolution procedure in paragraph (s), that the employee can never resume his or her former work activities.

As explained in the preceding discussion, OSHA's data show that in most cases, work restrictions will not be needed for 3 months because the employee will have recovered in less time. The standard permits the employer to end WRP before 3 months if a determination is made that the employee is recovered and able to return to his or her regular job. This is consistent with the principle that work restrictions or removals are temporary and protective in nature, and with OSHA's practice in other standards containing benefits similar to WRP (see *e.g.,* Lead, 43 FR 54440, Formaldehyde, 57 FR 22294). No party opposed the provision that WRP may be ended when the employee is able to return to his or her regular work.

Employers may also reduce their obligation to provide WRP benefits by addressing the MSD hazards in the job at an early date. Once the employer has controlled the MSD hazards so that the employee can resume his/her regular duties without endangering his/her recovery, work restrictions or work removal are no longer necessary. Controlling the MSD hazards in the job quickly is one way that employers may limit the number of days that MRP benefits must be paid.

The proposed rule contained no provision for ending WRP benefits once it becomes clear that the employee will not recover sufficiently to return to the job. Several commenters urged OSHA to include such a provision in the final rule (Exs. 500–218; 32–337–1). The AFL–CIO stated:

> [T]he AFL–CIO recommends that OSHA include [an additional] WRP cut-off point, consistent with the WRP provisions in other standards. An employer should be permitted to terminate WRP if and when it is determined that the employee is unable to return to the job * * *. At this point, temporary removal no longer serves OSHA's health protective goal and the worker presumably becomes eligible for workers' compensation.

Ex. 500–218. pp. 131, 127. OSHA agrees that a work restriction or work removal is no longer necessary once it is clear that the employee will not recover sufficiently to be able to return to the job. Accordingly, the final rule permits employers to end WRP benefits before the expiration of three months if a determination is made that the employee is permanently unable to return to his/her regular job.

Some participants suggested that the final rule should contain a limitation, similar to that in the FMLA, on the maximum number of days of benefits in any year. The Chamber of Commerce urged this approach, arguing that under the proposed structure, an employee could theoretically receive WRP for the maximum period, return to work for a day, and then receive another round of MRP benefits. By repeating this cycle, an employee could receive virtually his full annual pay and benefits while actually working only a few days during the year (Ex. 30–1722, pp. 81–82).

OSHA does not believe that the scenario posited by the Chamber is realistic. Employers can significantly reduce the likelihood of having to pay MRP benefits to the same employee on successive occasions by controlling the MSD hazards in their problem jobs effectively. By acting promptly to address MSD hazards, and effectively managing the MSDs that do occur, employers can ensure that, in most cases, injured employees will be able to return to work at full productivity and without the need for further restrictions. Moreover, while there may be some unusual instances in which employees will legitimately need work restrictions more than once in a year for the same job, employers need not allow employees to cycle endlessly in and out of WRP. If an employee requires work restrictions on several consecutive occasions despite the fact that the MSD hazards have been controlled to the extent required in the standard, that is a strong indication that the employee is physically unable to perform the job. As noted above, the standard permits the employer to end WRP if a determination is made that the employee is permanently unable to return to his regular job. For these reasons, OSHA does not believe that an express limitation on the number of days of WRP during the year is appropriate. The final rule thus contains safeguards which effectively limit the circumstances in which an employee could receive WRP benefits at repeated intervals in a year.

(c). Level of benefits. The final rule requires that the employment rights and benefits of employees be fully maintained for the duration of the WRP period. Employers must maintain the earnings of employees placed in restricted work jobs at their pre-WRP level, and must maintain the earnings of employees temporarily removed from work at 90% of their pre-WRP level. The proposed rule contained the same requirements as the final for maintenance of employment rights and benefits. However, the proposal required maintenance of either 100% or 90% of ''after-tax earnings,'' depending upon whether the employee was assigned restricted work or was temporarily removed.

Many participants criticized this provision. Although OSHA intended the provision to mean that the employee's net earnings should be 90% of the net earnings the employee would have received by working, a number of commenters thought the provision meant that the employee's gross WRP benefits should be equal to 90% of net earnings. Thus, the AFL–CIO argued that this formulation could result in WRP benefits being taxed twice, and would be problematic for employers to implement (Ex. 500–218, pp. 121–122). OSHA agrees, and has deleted the reference to ''after-tax earnings.'' It uses the word ''earnings'' in the final rule. Earnings generally means gross pay.

The AFL–CIO also objected to providing only 90% of pre-WRP wages to employees temporarily removed from work, arguing that full wage protection is necessary to encourage employee reporting and participation (Ex. 500–218, pp. 122). However, employees who remain at home do not incur certain expenses, such as commuting and child care expenses, incurred by employees who must report to work. Therefore, some reduction from the wages of workers removed from work is appropriate to balance the cost savings that these workers accrue; otherwise employees would reap a financial benefit from WRP (Ex. 32–22–1; p. 17). OSHA considers that restoring 90% of the earnings of employees removed from work approximates the portion of these employees' wages actually lost due to MSDs.

3. Offset Provision

The final rule permits an employer to reduce its WRP obligation to an employee with a work restriction by the amount that the employee receives in compensation for lost earnings during the period of restriction from a publicly or employer-funded compensation program, or receives in income from employment made possible by virtue of the employee's restriction. This provision is designed to ensure that employees will not receive more than current earnings as a result of a work restriction (64 FR 65848).

Several parties maintained that the provision will not achieve its purpose in preventing injured employees from receiving a double recovery because WRP payments will generally be paid before the employee receives workers' compensation benefits and state laws preclude employers from attaching such benefits (Exs. 32–22–1; 30–4467). The General Counsel of the New Mexico Workers' Compensation Administration expressed this view as follows:

> Whenever the workers' compensation system delays benefits for any legitimate reason, the worker is paid WRP under the Proposed Standard, and then later paid for *the same lost work time* by the employer's workers' compensation insurer. The employer has no legal mechanism for recapturing that portion of the WRP pay that was supposed to be offset. Since no state law currently has a provision allowing for reduction of workers' compensation benefits on the ground that WRP pay was already paid for the same injury, the various state workers' compensation laws will need to be revised to make the offset provision for WRP work.

Ex. 32–22–1, pp. 19–20 (emphasis in original).

OSHA does not agree that changes in state laws are needed to effectuate the offset provision. First, contrary to this commenter's assertion, some state laws already have adequate provision for employers to recoup wages paid to employees who later qualify for workers' compensation. For example, the New York state official charged with responsibility for the State's workers' compensation system testified that:

> [t]he offset provision would be effective even if the workers' compensation claim took more than six months to resolve because our system allows for payments of benefits to employers who have provided other compensation such as sick leave to employees prior to the award of compensation benefits.

Tr. 3354 (Eliot Spitzer). Employers are also free to structure their employment contracts to allow recovery of wages paid during a period for which workers' compensation benefits are awarded. Nothing in the record shows that contractual remedies would not be effective, or that employers would have greater difficulty in recouping WRP overpayments than they have in recouping other monies advanced to employees (Ex. 500–218, pp. 128–129). For these reasons, there is no basis to conclude that the offset provision will be unworkable or ineffective.

4. Fraud

A number of commenters argued that the WRP provision will entice large numbers of employees to attempt to secure these benefits fraudulently. These parties were concerned that employees will report MSDs that are not related to work activities, or will exaggerate their MSD symptoms to secure work restrictions that are not necessary or to extend work restrictions longer than needed (Exs. 30–1722; 32–241–4; 30–4467; 32–234–2; Tr. 6470, 9847–8, 14215). NCE *et al.*stated:

> The evidence is clear that the employees most likely to complain of musculoskeletal discomfort are those who do not like their jobs. These employees' subjective complaints must be taken as given under the proposed rule, and cannot be subjected to objective verification. When these workers are given the additional incentive of time off at 90 percent pay, or less demanding job tasks at 100 percent of pay, a vast increase in reported musculoskeletal pain is certain to follow.

Ex. 32–241–4, p. 185. Similarly, the Chamber of Commerce argued that, based on the extent of workers' compensation fraud nationwide, ''the only reasonable assumption is that the WRP provision will increase such fraud because the dollar amounts at issue are greater . . . And this problem is likely to be especially acute where, as here, the diagnosis at issue is . . . a loose collection of poorly defined signs and symptoms'' (Ex. 30–1722, p. 77).

OSHA does not believe that the record bears out these commenters' concerns. As a threshold matter, there is substantial evidence that worker-perpetrated fraud is but a very small part of the overall fraud problem in workers' compensation systems (see Exs. 500–97; 500–97–1; 500–97–2; 500–97–3; 500–218; 502–254; 502–258). The AFL-CIO noted that:

> [t]wo states that have devoted significant resources to workers compensation fraud investigation and reporting, California and Wisconsin, have found incidences of worker fraud to be minimal. In California, worker fraud was present in less than 3/10ths of one percent of total claims (Ex. 500–97–1); in Wisconsin, it was one tenth of one percent of claims (Ex. DC 78).

Ex. 500–218, p. 131. The former Commissioner of the West Virginia Workers' Compensation Fund testified that in her experience in administering claims, there was little evidence that workers prolonged their benefits by remaining out of work unnecessarily (Tr. 1733–34). Other witnesses agreed with this assessment (Tr. 3559–60 [James Ellenberger], Tr. 11001 [Madeline Sherod], Tr. 11102 [Trevor Schnell]). Accordingly, the experience gained in the worker's compensation field does not demonstrate a high potential for employee abuse of WRP.

In addition, the final rule contains features that will reduce the opportunity for fraud in administering WRP. First, work restrictions are required only for work-related MSDs and only if the employee's job meets certain objective screening criteria. These requirements are designed to ensure that there is a close nexus between the injury and significant exposure to ergonomic hazards at work. Moreover, work restrictions are not required unless an HCP or the employer itself has determined that they are necessary. Thus, even if an employee falsely reports MSD symptoms, work restrictions and WRP are not required unless the employee's job meets the screen and a medical professional selected by the employer determines that they are necessary. Therefore, commenters substantially overstate their case in asserting that subjective symptoms alone trigger work restrictions.

OSHA believes that HCPs, in particular, will play an important role in checking abuse. Health care professionals use a variety of techniques to identify fraud. Nothing in the record supports the notion that HCPs are frequently duped by false symptoms; to the contrary, HCPs are adept at evaluating the objectivity of patient claims. Moreover, data in the record shows that most HCPs are far more likely to recommend work restrictions than time away from work. (Ex. 500–118). Further, since 1992, the percentage of restricted workdays for all occupational injuries and illnesses reported to the BLS has increased by 50%, while the percentage of lost workdays has decreased by a substantial margin.

This is not to suggest that instances of fraudulent claims for WRP benefits will not occur, or that OSHA condones such conduct by employees. Rather, OSHA believes that the final rule provides effective safeguards employers can use to prevent employees from receiving WRP benefits to which they are not entitled. Therefore, the potential for fraud is not a basis for eliminating WRP.

Paragraph(s) What Must I Do if the Employee Consults His or Her Own HCP?

Paragraph (s) of the final rule establishes a procedure for resolving disagreements among HCPs. The proposed rule did not contain a comparable provision.

Numerous commenters, including both employer and employee representatives, argued that accurate medical assessments are critical if parties are to have confidence in decisions about work restrictions and WRP. A representative of the American College of Occupational and Environmental Physicians explained:

> [t]he central role that [medical] evaluations play in triggering requirements of the rule make the inclusion of a three-physician review in the ergonomic standard particularly appealing. We recommend that the standard provide for multiple physician review to sort out the differences of opinion and ambiguities in the diagnosis. The key element to triggering implementation of a program review should be based again on a bona-fide medical diagnosis in light of the corresponding duties.

Tr. 7654 (Dr. Robert McCunney). The AFL-CIO argued that multiple physician review or MPR is necessary to gain the trust and participation of employees. It asserted,

> [w]orkers have always been concerned about the objectivity and allegiance of employer-chosen physicians * * . MPR is important to assure workers that physician hostility to WRP will not result in adverse consequences when workers step forward and report. Without the possibility that a colleague will review, and possibly take issue with, a decision denying worker transfers or prematurely returning workers to hazardous exposures, employer physicians may feel financial pressure from employers to minimize WRP participation.

Ex. 500–218, p. 124. *See also* Exs. 32–111–4 (USWA); 32–85–3 (CWA).

The EEI voiced concern that if employees are allowed to choose the initial HCP, the person they select may not have the time or experience to work with employers in determining appropriate restrictions. It argued that:

> [t]he employee's personal healthcare provider may also not understand that assignment of work hardening and/or returning the employee to work on restricted duty as soon as possible are important in the recovery process. The employer is much more likely to select an HCP that recognizes the need to interface with the health and safety staff in developing restrictions

appropriate for the job and who will provide the type of care that is consistent for all employees at the work location. The employer will also have more control over the follow-up process, assuring that the follow-up is appropriate for the specific MSD and that it is completed in a timely manner.

Accordingly, EEI urges that any final standard clearly provide that employers shall select the healthcare provider for the WRP program, at least in the first instance. EEI would not object if the standard permits an employee to seek a second opinion.

Ex. 32–300–1, p. 30.

The Agency believes that the concerns expressed by all of these commenters are valid. OSHA agrees with the EEI that the employer should have the option of selecting the HCP to provide the initial recommendation on a work restriction. The final rule requires the employer to implement an MSD management process that includes ''access to an HCP.'' The employer may fulfill this obligation by arranging for the injured employee to visit an HCP selected by the employer. Alternatively, the employer may arrange for the employee initially to visit an HCP selected by the employee. Employers who choose this option should assure themselves that the HCP has the appropriate experience to work with the employer in determining work restrictions.

OSHA also agrees with commenters about the need to assure accuracy and competence in medical assessments. Accordingly, paragraph (s)(1) provides that if the employer selects the health care professional to make a recommendation about a work restriction, the employee may select a second HCP to review the first HCP's finding. If the employer allows the employee to select an HCP to make the initial recommendation on a work restriction, the rule does not provide for further review because OSHA expects that, in this situation, both parties will have confidence in the HCP's findings. On the other hand, if the employee has seen an HCP on his or her own, before the employer has exercised its option to select an HCP, the employer may refer the employee to a different HCP. In this case, the employee may rely on the recommendation he or she has already obtained as the second opinion for purposes of the final rule.

If the second HCP's determination differs from the first, the employer must take reasonable steps to arrange for the two HCPs to discuss and resolve their disagreement. This means that the employer should instruct his HCP to contact the employee's HCP to discuss the matter directly. If the two HCPs cannot resolve the conflict quickly, the employer and the employee, through their HCPs, must designate a third HCP to review the temporary work restriction or work removal determination. The employer must act consistently with the determination of the third HCP, unless the employer and employee agree to a restriction that is consistent with the opinion of at least one of the HCPs. Paragraph (s)(5) allows the employer and the employee to agree upon an alternative dispute resolution mechanism to use in lieu of the one set out in the final rule, if it is at least as protective of the employee. For example, the employer and employee may agree in advance that the employee will see a certain HCP, whose recommendation will be binding. The standard thus allows employers a degree of flexibility in structuring an alternative dispute resolution process, provided that the employee's right to a choice in the selection of HCPs is not compromised, and the process is expeditious. These provisions are similar to the multiple physician review mechanisms contained in OSHA health standards, such as lead and formaldehyde. OSHA adopts them in this final rule because they have proved effective in assuring that all parties have confidence in the accuracy and fairness of medical determinations about work restrictions and therefore contribute to the overall effectiveness of the rule's medical surveillance (MSD management in this rule) provisions.

Paragraph (t). Training

Training is a critically important element of the final ergonomics program standard, as it is of virtually every safety and health standard (Ex. 26–2). In training for ergonomics programs, the goal is to enable employees at all levels of the organization—managers, supervisors or team leaders, and employees—to: (1) Recognize the signs and symptoms of musculoskeletal disorders (MSDs) so that they can report them early (employees) and respond to them appropriately (managers, supervisors, and team leaders); (2) identify those job tasks that pose an increased risk to the worker of developing an MSD; and (3) have the knowledge and skills necessary to participate in the establishment's ergonomics program. The success of ergonomics programs depends to a great extent on the effectiveness of the training in ergonomics the employer provides.

Most comments on the proposed training provisions were supportive, although many commenters suggested modifications to the proposed requirements (see, *e.g.,* Exs. 30–3826, 32–111–4, 32–182–1, 30–3686, 32–198–4, 30–3765, 32–339–1, 32–198–4–15, 30–4538, 32–77–2, 32–185–3). Only a few commenters argued that training should not be addressed by the final rule (see, *e.g.,* Exs. 30–240, 30–541, 30–3867). The following discussion responds to public comment received and explains OSHA's reasons for including the requirements in paragraph (t) of the final rule.

In the proposal, OSHA included, for each core element of the program, a ''Basic Obligation'' provision. The purpose of these sections of the proposal was to summarize the more detailed subelements proposed for each core element. The final rule does not include these basic obligation provisions, because commenters found them confusing and not useful. Comments on specific aspects of the Basic Obligation section are discussed below, in connection with the individual training requirements of the final rule.

The proposed Basic Obligation section for training provided that any training required by the rule was to be provided ''at no cost to employees'' (see the Basic Obligation section for proposed section 1910.923). This proposed language expressed OSHA's intention for the employer to bear all of the costs associated with OSHA-required ergonomics training. For example, any training materials given to employees must be provided to them free of charge. Further, employees must be compensated at their regular rate of pay for time spent receiving training during regular work hours, and employees cannot be required to forfeit their regularly scheduled lunch or rest periods to attend training sessions. In addition, where training requires employees to travel, the employer must pay for the cost of travel, including any travel time occurring when the training activities are scheduled outside of the employee's normal work hours.

The final rule does not contain this specific proposed language about the costs of training, because that language is not necessary for OSHA to impose these costs on the employer. The proposed provision merely restated OSHA's longstanding policy, which requires employers to bear the costs of complying with safety and health requirements promulgated under the Act. OSHA finds it reasonable and appropriate for employers to bear the costs of training because, under the Occupational Safety and Health Act of 1970, employers are responsible for providing a safe and healthful workplace, and training is an integral part of this responsibility. It is clear that having employees bear such costs would discourage participation in training activities, and would thus limit the effectiveness of the rule's training requirements.

Several organizations commented on OSHA's interpretation of the proposed ''at no cost to employees'' language (see, *e.g.,* Exs. 30–3813, 30–3686, 32–339–1). With reference to the preamble to the proposal [64 FR 65833], which explained that employees could not be required to forfeit regularly scheduled lunch or rest periods to attend training sessions, one organization stated that OSHA had cited no evidence showing that employees receiving training on MSDs during ''brown bag'' lunch sessions or during ''scheduled rest periods'' would be harmed by this practice. This commenter contended further that OSHA's interpretation of the ''no-cost'' provision was an intrusion into workplace management and scheduling, which should be the employer's exclusive prerogative (Ex. 30–3813). In contrast, other organizations supported the ''no cost to employees'' requirements of the proposed rule (Ex. 30–3686) and additionally urged OSHA to limit training to working hours (Ex. 32–339–1).

OSHA has no objection to training during brown bag sessions or breaks, provided that employees are paid for this time (and, of course, that no laws governing break times are contravened to comply with this provision). Many employers do have paid lunch hours or half-hours and breaks where training can occur without risking non-compliance with this provision. However, if these time periods belong to employees, *i.e.,* are not periods that are on the clock, they cannot be used for the training required by this standard.

Who Should be Trained?

OSHA proposed that employees in ''problem'' jobs (defined in the proposal as those jobs in which an employee had experienced a covered MSD and performed activities involving exposure to risk factors for a substantial amount (or as a ''core element'' of the work shift), their supervisors, and persons involved in the ergonomics program (except for outside consultants) be trained initially, periodically as needed, and at least every three years. The final rule, at paragraph (t)(1), includes similar requirements, although the final rule's initial and follow-up training requirements apply only to jobs that meet the Action Trigger, rather than to ''problem jobs,'' as proposed. In addition, while the final rule requires initial and 3-year follow-up training, it does not require ''refresher'' training at other intervals. The specified initial and follow-up training requirements are well-suited to the revised format of the standard and the Action Trigger concept.

OSHA's reasoning in including these requirements in the final rule is that, once employees in jobs meeting the action trigger have been trained, they will be able to report MSD hazards and problems early enough to prevent problems from becoming worse and to protect other employees in the same job from incurring a similar MSD. Early reporting informs employers of the need to address MSD hazards and provide MSD management. Trained employees can also participate more effectively in the program and thus better protect themselves by working safely. OSHA also believes that the supervisors (or team leaders or lead employees) of employees in these jobs must be trained because they are the personnel to whom employees report their symptoms and the presence of MSD hazards. Supervisors are in a position to ensure that employees in such jobs understand the conditions that may lead to MSDs and use the work practices and procedures established by the employer to control MSD hazards. Also, in many cases, supervisors are in a position to observe MSD hazards first hand and to recognize when MSDs are developing in the workers they supervise.

OSHA also believes that training is critical for those individuals who establish, administer, and implement the employer's ergonomics program. Because these managers represent the employer, it is in the employer's best interest that program administrators and others responsible for implementing the program be as knowledgeable as possible. Also, as these managers become more knowledgeable, they will provide better training to their employees in the ergonomics program. Of course, as the proposal noted, outside consultants do not have to have employer-provided training because consultants are responsible for preparing themselves to perform their professional duties.

The question of who should be trained was a significant issue in the rulemaking. Commenters offered opinions on a variety of issues and represented conflicting viewpoints. The major issues with respect to who should be trained under the ergonomics rule were:

- The scope of the training provision,
- The number of employees to be trained,
- Whether supervisory employees should be trained, and
- The training and qualifications of trainers.

Some commenters urged OSHA to be more inclusive in the employees required to be trained. They stated that all workers, or all general industry employees (see, *e.g.,* Exs. 30–3826, 30–297, 30–4538), or all workers in the industry (see, *e.g.,* Ex. 30–3686) should be trained. Some stated that, although all employees should receive training, employers should conduct more extensive training specifically for those in problem jobs (see, *e.g.,* Ex. 30–4538). The thrust of these comments, in general, was that the training required by the standard should be expanded beyond employees in problem jobs (see, *e.g.,* Exs. 30–3826, 30–3686, 32–182–1, 30–3765, 32–198–4, 30–297, 30–4538). For example, Dow Chemical stated,

> Employees having an active role in the prevention of MSD injuries and information on how best to recognize and control MSD hazards is a necessary component of a successful program. In fact, Dow encourages such training for employees, beyond whether they are in a ''problem job'' or not. All work activities involve some bodily movement and therefore MSD risks are always present. Dow supports internally a more pro-active sharing of this type of information rather than waiting for an MSD to present itself (Exhibit 30–3765).

Expanding the scope of the required training to include more employees, and to include employees who have not experienced an MSD, would clearly make this program element more proactive, as many commenters urged (see, *e.g.,* Exs. 30–3826, 32–111–4, 30–3686, 32–182–1). Some participants argued that the full program, including training, should be implemented without waiting for workers to report injuries (see, *e.g.,* Ex. 32–198–4). Others suggested that training be part of new employee orientation (see, *e.g.,* Ex. 500–180–51) be provided when workers are transferred (Ex. 32–182–1), or be given when the ergonomics program is first implemented or new employees are hired (see, *e.g.,* Ex. 32–198–4). One commenter stated that the training requirements of the proposed rule, unlike the case in other OSHA rules, do not apply to workers who are only *potentially* exposed but instead apply only to workers who are actually exposed (Ex. 32–339–1).

> Given the central role of the workers in an effective ergonomics program (*e.g.,* reporting symptoms and hazards and making recommendations about controls), we believe that more regular training is warranted (Ex. 32–339–1).

Another comment addressed the effect that training only some employees might have on employee morale. This commenter noted that, in some ergonomics pilot training programs, employees who perceived that they were not going to be included in the program (whether rightly or wrongly) because they were not trained when others were, felt excluded and were later less cooperative (Ex. 32–194–4).

OSHA also received comments recommending that: (1) training be limited to employees with MSDs and the employees' supervisors (Ex. 30–3813) rather than, as proposed, to all employees with the same job as the injured employee; (2) different groups of employees be given different levels of training (Ex. 30–240); and (3) the formal program apply only to specific employees in jobs where ergonomic issues are prevalent (Ex. 30–240). One commenter stated that training should be triggered only when a statistically significant percentage of employees in a job have incurred, within the year, work-related, HCP-diagnosed MSDs that resulted in days away from work (Ex. 30–3344).

The final rule's training provisions (paragraph (t)), together with the informational requirements in paragraph (d), address many of the issues raised by commenters. First, OSHA has adopted a ''tiered'' approach to training. The Agency agrees that all employees should receive orientation or awareness training (see, *e.g.,* Exs. 30–3686, 32–182–1, 32–198–4) but those at greater risk must receive more extensive training (see, *e.g.,* Exs. 30–3686, 32–339–1, 30–240). Paragraph (d) of the final rule requires that general awareness information be provided to all current employees and new hires. This new provision also addresses the concerns of those commenters (see, *e.g.,* Exs. 30–3826, 30–297, 30–4538, 30–3686, 32–182–1, 30–3715, 32–198–4) who argued that as many employees as possible should be aware of MSD hazards and how to prevent them. The awareness information required by final paragraph (d) also should help to avoid the dampening effect on employee morale noted by one commenter (Ex. 32–194–4). (The summary and explanation for paragraph (d), above, provides more detail on the general information requirements.)

Second, training is required by the final rule for employees in jobs that meet the standard's Action Trigger. OSHA views the occurrence of a work-related MSD and the presence of risk factor(s) at the level(s) indicated by the Basic Screening Tool as an indication that the job is one that warrants a closer look. Such a job has the potential to expose workers in the job to MSD hazards. Because the two-part action trigger in paragraph (e) triggers training for the injured employee and for all other employees in the establishment with the same job, the final rule's structure is more like that of other OSHA standards (*e.g.,* the hearing conservation amendment to the occupational noise standard, 29 CFR 1910.95), as some commenters suggested (see, *e.g.,* Ex. 32–339–1). However, because OSHA has designed the final rule to target those situations where the problem is most serious, the standard's training requirements are triggered for a job only when the action trigger has been met for that job, and not, as some commenters suggested, when the program is first implemented (see, *e.g.,* Exs. 32–198–4).

The Agency does not agree with those commenters who stated that training should be required only for injured employees and their supervisors (Ex. 30–3813), or only for employees in jobs where ergonomic issues are ''prevalent'' (Ex. 30–240), or only for employees in jobs that have caused MSDs in a statistically significant percentage of employees within the prior year (Ex. 30-3344). Restricting the number of employees receiving training in ways suggested by these commenters would be, in OSHA's view, both inappropriate and insufficiently protective. First, limiting training to injured employees and their supervisors would eliminate one of the standard's proactive features, *i.e.,* that other employees holding the same job as the injured employee be trained in the risk factors in that job, the signs and symptoms associated with the MSDs caused by those risk factors, and ways to protect themselves from experiencing an MSD. OSHA believes that this provision of the standard will contribute substantially to the standard's effectiveness by ensuring that all employees in these higher risk jobs receive training. A recent study showed that employers were likely to limit their efforts to control MSD hazards to the injured worker's job and not to extend preventive practices to other workers in the establishment who had the same job (Ex. 30–651–2). OSHA believes that this provision of the standard will ensure that all at-risk workers in the same job will be protected. Absent such a provision, this preventive effect would be lost.

Third, limiting training only to employees in jobs where ergonomic injuries are ''prevalent'' (Ex. 30–240) or where a statistically significant percentage of employees have had an MSD in the last year (Ex. 30–3344) would deny the standard's training benefits to all injured and potentially exposed workers except those working in very large establishments, since only such establishments would have enough employees in a given job to meet the prevalence or statistically significant tests suggested by these commenters. Such an approach is clearly unprotective for the many thousands of workers in small- or mid-sized establishments who would not receive training even in cases where they have experienced an MSD incident.

OSHA concludes, after a comprehensive review of the record on the issue of who should receive the training required by the final rule, that paragraph (t)(1) strikes the right balance on inclusiveness. It does this by requiring training for each employee who has experienced an MSD and works in a job that meets the Action Trigger, and all other employees working in that job.

The final rule requires the supervisors or team leaders of these employees to be trained, so that they will encourage early reporting, know how to respond to employee reports, reinforce good work practices, and be familiar with ergonomic principles and practices. Several commenters (Exs. 30–3765, 32–198–4, 30–3859) commented on the proposed requirement to train the supervisors of those in higher risk jobs. One commenter noted that the term ''supervisor'' is no longer used in some workplaces, which are organized in less traditional management structures (Ex. 30–3765). This commenter pointed out that some managers may direct more than a hundred employees, and that these employees may be widely dispersed geographically. In the view of this commenter, the rule should state that employers must train ''knowledgeable resources,'' rather than stipulating that supervisors must be trained. In the final rule (at paragraph (t)(1)(ii)), OSHA states that employers are required to train the supervisors or ''team leaders'' of employees in jobs that meet the Action Trigger. The addition of the term ''team leaders'' conveys OSHA's intent, which is to require first-level management personnel to be trained, whatever their official title may be (supervisor, team leader, team manager, knowledgeable resource, and so forth). OSHA is also aware that many workplaces rely on members of an ergonomics committee, joint labor-management, or a trained group of employees (see, *e.g.,* Ex. 30–115); however, the standard does not specifically address the training of these employees.

Paragraph (t)(1)(iii) specifies that employers also must train ''other employees involved in setting up and managing'' the employer's ergonomics program. This provision is similar to the proposed provision, except that it substitutes ''employees'' for ''persons'' (the proposed term). OSHA has directed this provision to employees rather than persons because doing so makes it clear that the Agency is not regulating individuals operating outside of the employment relationship.

Initial and Refresher Training. The proposed rule required that training be given in accordance with the following timetable:

For employees in problem jobs and their supervisors.	(1) When a problem job is defined; (2) When initially assigned to a problem job; (3) Periodically as needed (*e.g.,* when new hazards are identified in a problem job or changes are made to a problem job that may increase exposure to MSD hazards); and (4) At least every 3 years.
For persons involved in setting up and managing the ergonomics program.	(1) When they are initially assigned to setting up and managing the ergonomics program; (2) Periodically as needed (*e.g.,* when evaluation reveals significant deficiencies in the program, when significant changes are made in the ergonomics program); and (3) At least every 3 years.

In the final rule, OSHA has revised the timetable for initial training to reflect the addition of the Action Trigger to the standard, and to allow time for the employer to conduct the job screening process and implement the ergonomic program. Accordingly, paragraph (t)(4) provides the fillowing timeframes for initial training: When the employer determines that an employee's job meets the Action Trigger, the employer has 45 days from that time to train employees involved in setting up and managing the program, and 90 days from that time to train each current employee in that job and their supervisor and team leader. Also, if the employer assigns a new or current employee to a job that the employer has already determined meets the Action Trigger, that employee must be trained prior to starting the job.

Paragraph (t)(1) of the final rule also requires follow-up training, every three years, for employees whose jobs meet the Action Trigger. This requirement differs from the corresponding proposed provision, which did not rely upon the Action Trigger concept.

Several commenters (see, *e.g.,* Exs. 32–198–4, 32–198–1/42, 30–3686, 32–339–1, 30–2116, 30–2825, 30–2847, 30–3001, 30–3033, 30–3034, 30–3035, 30–3258, 30–3332, 30–4159–30–4536, 30–4546, 30–4547) urged OSHA to require refresher training more frequently than once every three years.

Some of the reasons cited by these commenters for more frequent training included:

• Many workers experience problems in less than a year (Ex. 32–198–4–1/42).

• Training should be required annually and whenever jobs or conditions change (Ex. 30–3686).

• Employers should train every two years at a minimum because many employers are already providing training on an annual basis (Ex. 32–198–4).

Other commenters requested that OSHA require training less often or require training less often in some situations (see, *e.g.,* Exs. 32–300–1, 30–3813, 30–3765, 30–327, 30–710, 30–2725, 30–3284, 30–4046). Some specific reasons given for less frequent retraining were:

• There should not be a minimum three year retraining provision for employees where the reported MSD has resolved within the three years and no other MSDs (affecting the same part of the body) have been reported in that job (Ex. 30–3813).

• Employees will retain knowledge about their job's core functions, like how to use controls and work practices properly, even without training (Exs. 32–300–1, 30–3284).

• OSHA should allow employees and supervisors to demonstrate knowledge retention so that they can be exempt from the three year retraining requirement (see, *e.g.,* Exs. 32–300-1, 30–327, 30–1671, 30–328).

• Program administrators should be allowed to bypass portions of initial and refresher training if they already possess background training. This group could include health and safety personnel, medically trained personnel, and ergonomists (see, *e.g.,* 32–300–1, 30–327, 30–1671, 30–3284).

OSHA responds to these comments on the appropriate frequency of training as follows. First, OSHA believes that refresher training every three years for those in higher-risk jobs is appropriate, given the very broad range and diverse nature of businesses covered by this standard. For example, the number of employees in the average business covered by this standard is 16; such a business is likely to experience not more than one or two MSDs in a given year, at most, which means that one or two employees will receive initial training every year and one or two will need refresher training (once the standard has been in effect for a few years). In a business such as this, ergonomics awareness is likely to be quite high, both because of the amount of training going on and because of the job hazard anlysis and control activities being conducted. In other words, the initial training and 3-year follow-up training requirements will virtually ensure that ergonomics training will be a regular part of the program for many employers. In response to those commenters who argued that refresher training every three years was unnecessary or burdensome, OSHA notes that the standard allows employers considerable flexibility in the form that training must take. For example, although all of the required topics must be addressed in the refresher training, trainers who observe that trainees ''know the basics'' are free to spend more of the training time on such workplace-specific topics as changes to workstations that have taken place since the last training.

Some commenters argued that many workplaces are static rather than dynamic in nature and therefore that workers in them do not need refresher training (see, *e.g.*, Exs. 30–2835, 30–3356). OSHA disagrees. MSDs occur in workplaces with fixed workstations, in service industry jobs, and in office settings; indeed, one of the striking characteristics of MSDs is that they occur in all general industry sectors (see the risk assessment section of this preamble, Section V). Whenever MSDs occur in jobs that meet the action trigger, OSHA believes that workers in these jobs should be trained initially, and that they should also receive follow-up training at least every three years. This approach ensures that those workers who are clearly at risk have the knowledge and skills they need to work as safely in those jobs as possible. The approach taken in the final rule—to require refresher training only for employees, and the supervisors of employees, in jobs that meet the Action Trigger—is also responsive to those commenters who argued that no such training should be required if the problem has gone away (see, *e.g.*, Ex. 30–3813). OSHA is unsympathetic to those who believe that employees do not need refresher training because they will remember what they need to know about the ''core functions'' of their job (see, *e.g.*, Exs. 32–300–1, 30–3284). This is not OSHA's experience, and the thousands of fatal and disabling injuries that occur in U.S. workplaces every year confirm the fact that workers and their supervisors often do not remember the safe operating procedures in which they were trained.

OSHA has not adopted the suggestion of some commenters (see, *e.g.*, Exs. 32–300–1, 30–327, 30–1671, 30–328) that employees and supervisors who can demonstrate that they have retained the information they learned be exempted from refresher training. OSHA has not done so because refresher training is only required every three years and the Agency believes that periodic retraining is appropriate for all employees in the program. For the same reasons, the standard does not permit managers and supervisors to demonstrate knowledge and be exempted from refresher training, as some commenters suggested (see, *e.g.*, Exs. 32–300–1, 30–327, 30–1671, 30–3284). However, the final rule does not use the word ''persons,'' as the proposal did, because OSHA agrees with commenters that persons who are not employees (*e.g.*, independent or self-employed ergonomists, safety specialists, industrial hygienists, and so forth) are responsible for their own training.

To those commenters who argued that more frequent refresher training should be required because many employers are already doing it (see, *e.g.*, Ex. 32–198–4), OSHA responds that employers are always free to provide more frequent training than OSHA requires. OSHA does not agree, as some commenters maintained, that employees will continue to remember the essential elements of their training, such as how to implement controls, without refresher training. Instead, OSHA believes that all employees in jobs posing MSD hazards will benefit from the reminders and updating that refresher training provides.

OSHA also is not persuaded by arguments (see, *e.g.*, Exs. 30–3765, 30–3813) that program managers should not have to be retrained. These personnel, like employees, will benefit from renewing their knowledge base and updating their skills every three years, particularly since they only receive this training if the employees under their supervision are in jobs that warrant it.

OSHA does agree that training is more difficult in workplaces with high turnover. The Agency believes that the standard may help employers to reduce turnover, as good ergonomics programs have done in many workplaces (see the case study table in Section VI of the preamble).

The difficulties of training short-term employees, some of whom may only stay with the host employer for a week or less, were discussed by one commenter (Ex. 30–240). According to this comment, training short-term employees in a high-turnover environment is both time consuming and resource-intensive. OSHA agrees that this is the case; however, ergonomics training is essential for each employee who experiences an MSD incident in a job that meets the Action Trigger, even if that employee is only in the job for a few weeks or months. Employers may also find that training helps to reduce turnover to the extent that ergonomic stress plays a part in employees' decisions to leave employment. As discussed below, paragraph (t)(5) also allows that if an employee has been trained in a topic required by paragraph (t)(2) within the previous 3 years, the employer need not provide initial training in that topic. OSHA believes that this provision will reduce the burden on employers in high-turnover industries, at least to some extent.

The training and qualifications of the individuals providing the training required by the final rule was the topic of several comments (see, *e.g.*, Exs. 32–111–4, 30–3686, 32–194–4, 32–182–1). These participants stressed the importance of the qualifications of the trainers to effective ergonomics programs, and one commenter (Ex. 32–194–4) expressed concern that, if program evaluations were conducted by untrained managers, inadequate evaluations could result.

OSHA agrees that the knowledge and skills of those administering ergonomics training play a major role in the effectiveness of the training. However, the final rule does not specify the credentials or experience such trainers or program managers must have. Ergonomists, safety professionals, industrial hygienists, and individuals who have taken ergonomics courses, attended train-the-trainer sessions, and learned the basics of ergonomics on-the-job are currently providing the training being presented in existing, effective ergonomics programs and have demonstrated their ability to be effective trainers. A recent study (Ex. 500–71–64) from the *International Journal of Industrial Ergonomics* reports that trained workers do an exceptional job in identifying risk factors and solutions: in 65 to 85 percent of cases, professional ergonomists and trained workers identified the same risk factors when they performed job hazard analyses. The authors of this study concluded that ''users [trained employees] can identify rather reliably the risk factors in the jobs.''

Train-the-trainer sessions involving employees also have achieved excellent results; for example, a hospital that introduced patient handling equipment and conducted extensive train-the-trainer and employee training credits the program with reducing lost-time injuries by 64% within the first year (Ex. 500–71–61). The record thus demonstrates that persons with a wide range of credentials, skills, and experience can effectively train employees, supervisors, and managers, provided that they themselves have been well-trained.

Topics for Training. Paragraph (t)(2) of the final rule requires that the employees identified in paragraph (t)(1) be trained in the following topics (as appropriate to their responsibilities in the ergonomics program):

- The employer's ergonomics program and their role in it;
- The signs and symptoms of MSDs and ways of reporting them;
- The risk factors and MSD hazards present in the employee's job, as identified by the Basic Screening Tool and the job hazard analysis;
- The employer's plan and timetable for addressing the risk factors and hazards identified;
- How to use engineering, work practice, and administrative controls, or any PPE, that will be used in the job; and
- How to evaluate the effectiveness of the control approach adopted to reduce the risk factors and MSD hazards.

With two exceptions, these are the same training topics (with minor editorial changes) that OSHA proposed. The two exceptions are specific training in the requirements of the standard and in the importance of early reporting of MSD signs and symptoms. OSHA has not included these topics in the list of training topics in the final rule because the hazard information provided to employees under paragraph (d) of this standard already includes this information. Thus all employers covered by the standard will have access to a summary of the standard and will be aware of the importance of early reporting.

OSHA believes that training in the topics listed in paragraph (t)(2) is an important way to ensure that employees at all levels of the organization have the information and skills they need to participate effectively in the ergonomics program. Only workers trained to recognize MSD hazards and MSD signs and symptoms, to use the controls implemented to reduce these hazards, and to evaluate the effectiveness of these controls, can make the program work in terms of reducing work-related MSDs.

There was substantial disagreement among those commenters who addressed the content of the proposed training requirements. Several felt that the list of training topics should be expanded, while others argued that some requirements should be deleted. In addition, many commenters submitted data and information showing that training programs can achieve significant results in reducing workplace MSD hazards and associated MSDs.

Examples of some of the suggestions commenters had for revising the proposed training topics included:

• OSHA should specifically require that employers provide training on the requirements for medical management, Work Restriction Protection, and the standard's prohibition against discouraging workers reports (Exs. 32–111–4, 32–339–1).

• Work Restriction Protection should be explained during the initial training (Exs. 30–4538, 32–339–1).

• First-line supervisors as well as the program manager should have hazard analysis training (Ex. 30–3826).

• Training should include discussions of medical records confidentiality, job hazard analysis (including ergonomic assessment of work stations) and disease and disability related to ergonomic injuries (Ex. 30–3686).

• OSHA should include both detailed and more general topics in initial training, and job-specific training for employees in problem jobs and their supervisors (Ex. 32–198–4).

• Training should cover the importance of height differences among employees, the training of lift team members, and the importance of labeling packages with their weights (Exs. 32–461–1, 30–115, 30–4538).

Other commenters recommended that certain subjects be deleted from the required training topics. For example, several commenters suggested that training on the specific requirements of the standard be deleted from the list (see, *e.g.,* Exs. 30–3765, 32–300–1, 30–240, 30–3284). These commenters were of the opinion that there is no need to provide in-depth training on the standard itself, but that the training should instead focus on elements of the standard only as they specifically apply to the company's program. Further, these commenters believed that employees have ample access and opportunity to familiarize themselves with OSHA standards, including access to OSHA's internet homepage (see, *e.g.,* Ex. 330–3765).

OSHA agrees that the specific suggestions for additional training content made by commenters would be useful to employees. However, the Agency has decided to require only that employees be trained in those basic topics that are essential to worker protection. The required topics are general, in order to allow the flexibility needed in different workplace situations. This approach is consistent with the training content requirements of other OSHA standards (see, *e.g.,* 29 CFR 1910.1018 and 29 CFR 1910.147). The final rule requires training in the employer's ergonomics program and each employee's role in it; the signs and symptoms of MSDs and ways of reporting them; the risk factors and MSD hazards present in the employee's job, as identified by the Basic Screening Tool and the job hazard analysis; the employer's plan for addressing identified hazards, including the employer's timetable to abate the hazards identified; training in how to use the controls in the job, including any personal protective equipment; and how to evaluate the effectiveness of the control approach used.

OSHA believes that the required topics constitute a minimal training program and recognizes that many employers may choose to administer more extensive training. OSHA anticipates that many employers will cover such topics in their training programs as OSHA's discrimination regulations (Section 11(c) of the Act), Work Restriction Protection, MSD management, and multiple HCP review. Several of these topics are briefly addressed in the information on the standard employees receive in response to the requirements of paragraph (d). OSHA believes that training under paragraph (t) should concentrate primarily on MSDs and MSD hazards that are specific to the employee's job. OSHA has also not included the more detailed topics—package weight labeling, the importance of height differences among employees, lift team training, and so forth—suggested by commenters (see, *e.g.,* Exs. 32–461–1, 30–115, 30–4538). Such topics are workplace-specific and thus not appropriate to include in general training requirements that will apply to all workplaces covered by the standard.

Some commenters recommended that OSHA expand its training activities by developing outreach training programs and other compliance assistance materials (see, *e.g.,* Exs. 30–3686, 30–4538, 32–198–4, 30–3826, 30–614, 30–1037, 30–2806). Some specific suggestions were that OSHA develop a sample curriculum, including audiovisuals (Ex. 30–4538), or that OSHA provide a curriculum, instructor materials (and translations), and training videos at minimal cost (Ex. 32–198–4). Other comments urged OSHA to establish an ''advice line'' for program managers (those setting up and implementing the program) and urged employers to work closely with health care professionals. These commenters were concerned that, without such assistance, managers would be tempted to buy expensive but ineffective ergonomic fixes and purchase products that do not address the root cause of the problem (Exs. 30–614–, 30–898, 30–4139).

Other stakeholders suggested that OSHA train its compliance officers to have, at a minimum, the same level of knowledge as consultants advising employers in ergonomics programs (see, *e.g.,* Exs. 30–1037, 30–3922). These commenters urged the OSHA training centers to make ergonomic certification programs and other courses available to the public or at least to make employers aware of sample programs that already exist (see, *e.g.,* Exs. 30–1037, 30–3123, 30–3128).

OSHA does have programs in place to help employers with their ergonomics programs. The Agency offers free consultation services through the states. The OSHA consultation program is specifically designed for small- and medium-size organizations (*i.e.,* employers with 250 employees or fewer per site or 500 per organization). These services are confidential, and consultants will not issue citations or propose penalties. OSHA also offers off-site services to larger organizations and on-site services on a priority basis if resources permit. OSHA staff are available to answer questions from the public any time during OSHA working hours. In addition, OSHA makes a wide range of ergonomics-related materials available on the Agency's website, www.osha.gov.

With respect to the training of compliance officers and other OSHA staff, OSHA's Training Institute in Des Plaines, Illinois, provides basic and advanced ergonomics courses for Federal and State compliance officers, State consultants, other Federal agency personnel, and private sector employers, employees and their representatives. Also, the Training Institute has established Training Institute Education Centers, which are nonprofit colleges, universities, and other organizations selected after competition for participation in the program. In addition, OSHA provides funds to nonprofit organizations through grants to conduct workplace training. Grants are awarded annually to grant recipients, who contribute at least 20% of the total grant cost. OSHA has already trained many of its CSHOs extensively in ergonomics, and has made regional ergonomics coordinators available in the regional offices. In addition, OSHA is making extensive outreach materials on ergonomics available with the final standard.

Effectiveness of Training. Some stakeholders submitted data to the record on the effectiveness of ergonomics training. Several commenters noted that they had developed training programs, had coordinated programs through outside organizations such as universities, or were in the process of developing or testing training programs (see, *e.g.,* Exs. 30–3826, 32–198–4, 32–77–2, 32–185–3, 30–1294, 30–3336, Tr. 2776, Tr. 2761, 30–449, 30–2713, 30–3368, 30–3758, 30–3867, Tr. 3129–3219, Tr. 14969–15072). Stakeholders described some of the achievements of these programs (see, *e.g.,* Exs. 32–198–4, 32–185–3, 30–449, 30–3336, 30–3758, 30–3867, Tr. 7982), including their contribution to the decrease in the rate of MSDs observed among their members (Tr. 7982) and continued reductions in workers' compensation costs even in the face of increases in wages and health care costs (Exs. 30–3336, 30–3867, 30–4496). The thrust of these comments is that ergonomically aware workers can help their co-workers and their employers to prevent MSDs (Ex. 30–3758).

Several studies in the record demonstrate the benefits of ergonomics training. For example, a study by Parenmark, Engvall, and Malmkvist showed that workers receiving training had a reduced number of lost workdays due to MSDs compared with untrained controls (Ex. 26-6). The number of days lost as a result of arm-neck-shoulder complaints was reduced by half in the trained new hires compared with the control group (Ex. 26–6, Table 2).

An AFGE health and safety representative referenced an Ergonomic Workplace Survey conducted by Rani Lueder, CPE, for the Social Security Administration in 1997 (Ex. 30–449). The large majority of respondents who received the training considered the training helpful, and the trained respondents reported consistently lower rates of discomfort for all body parts, were more willing to report MSD discomfort to their supervisors, and were more satisfied than untrained workers with their supervisors' responses (Ex. 30–499). Also, respondents who were trained were more likely to adjust their chairs, worktables, and other equipment to reduce the risk factors present.

Many commenters at the hearings described the training component of their ergonomics programs (see, *e.g.,* Tr. 12367–12373, Tr. 7977–7982). The extent of the training being administered varied widely, from very simple training to comprehensive efforts. OSHA believes that the training program required by the final rule will do much to increase the level of ergonomics knowledge and understanding among employees, their supervisors, and managers. This knowledge, in turn, will translate in practice to fewer MSDs, improved morale, and greater productivity. There is evidence in the record that good training programs operate in just this way. For example, a 1997 article in the American Journal of Health Promotion [Ex. 500–71–63] reports that ergonomics training programs lasting about an hour and administered to computer operators described in the article as ''high risk'' led every trainee subsequently to make changes either in their workstations or their work practices. About two-thirds of the trainees made ergonomically advantageous changes to both.

Another study (Ex. 500–71–59) reports that factory processing line workers who were trained in MSD hazard recognition were subsequently better able to recognize hazards and more willing to report them to their supervisors. OSHA believes that the experiences of these companies will be repeated frequently once the final rule's training requirements are implemented.

Retraining of employees who have already received training. The proposed rule stated that employers do not have to provide initial training to current employees, new employees and persons involved in setting up and managing the ergonomics program if they have received equivalent training in the subjects this standard requires within the last 3 years. However, the proposal stated that employers must provide initial training to such individuals in any of the required topics that their prior training did not cover. The final rule, at paragraph (t)(5), provides that if an employee has received training in a required topic within the previous 3 years, the employer need not provide initial training to that employee in that topic.

Several commenters supported this proposed requirement (see, *e.g.*, Exs. 30–3765, 32–300–1, 30–1671, 30–3284). Some organizations asked OSHA to clarify how the Agency expects an employer to verify such prior training (Exs. 30–3826, 32–300–1). OSHA does not require employers availing themselves of this ''portability of training'' provision to have written documentation of the employee's prior training or to require the employee to pass an examination (Ex. 30–3826). The Agency does, however, expect employers who wish to benefit from this provision to assure themselves that employees have in fact had the prior training and have sufficient knowledge to work safely.

A number of commenters objected either to the prior training exemption altogether or to the fact that OSHA proposed to permit training given in the 3 years prior to the compliance date to qualify for the portability exemption (see, *e.g.*, Exs. 30–3686, 30–2116, 30–2809, 30–2825, 30–2847, 30–3001, 30–3033, 30–3035, 30–3258, 30–3332, 30–4159, 30–4536, 30–4546, 30–4547). OSHA has decided in the final rule to retain the training exemption as proposed, because the Agency believes that employees who have received all of the required training elsewhere do not need to be retrained until their refresher training date comes up. Although employees who have had prior training are not required to take initial training, all employees in jobs that meet the Action Trigger must receive refresher training.

OSHA received several non-specific comments only tangentially related to the proposed training provisions. These primarily concerned what the commenters perceived as ''vagueness'' in the proposed language of the regulatory text. For example, some participants believe that employers will not be able to train their employees because, in their opinion, the standard isn't clear about the steps that need to be taken (see, *e.g.*, Exs. 32–368–1, 30–325, 30–494, 30–2846) and assert that this will make training more difficult and costly than usual (see, *e.g.*, Exs. 32–368–1, 30–1668, 30–2846, 30–3781, 30–3593).

In the final rule, OSHA has revised the proposed standard's training requirements extensively and has clarified areas of overlap and confusion. For example, the basic information requirements in paragraph (d) now apply to all covered employers and are intended to ensure that all employees are familiar with the elements of the OSHA standard, and this topic is no longer also included in the required training topics.

Some commenters argued that OSHA should phase in compliance requirements for the training provisions because it will take time to develop adequate in-house materials. OSHA is aware that it takes time to develop training materials, but OSHA is also aware that many trade associations and other organizations, as well as employers, already have such materials. Further, OSHA is making many outreach materials available at the time the standard is published and in the months thereafter. Consequently, OSHA believes that the time allowed for employers to come into compliance with the rule's training requirements (see paragraph (x)) is appropriate. The Agency is phasing in all elements of the final rule; therefore, an employer's earliest requirement to train employees under this standard will not arise for about a year after the publication date of the final rule.

What employers must do to ensure that employees understand training. OSHA proposed that employers provide ''training and information in language that employees understand.'' The proposal also stated that employers must ''give and receive answers.'' The final rule, at paragraph (t)(3), contains essentially the same requirements. These requirements provide individual employers with considerable flexibility in ways of achieving compliance (*e.g.*, the ''language'' may be one all trainees understand rather than the trainee's native language, so long as the trainee understands the language well enough to fully understand the training). Employees have varying educational levels, literacy, and language skills, and training must be presented in a language and at a level of understanding that accounts for these differences in order to meet the intent of the final requirement that individuals being trained understand the specified training elements.

The final rule requires that employers provide opportunities for employees to ask questions and receive answers about the establishment's ergonomics program and anything covered by the training. Again, employers have complete flexibility in the methods they use to comply with this requirement. For example, employers could choose to to do the training in-house or to use an outside trainer. Other alternatives would be for the employer to have a qualified trainer available by phone, or through a classroom video-conference.

Commenters addressed three issues related to the proposed requirement that training be understandable to the employee and that employees have the opportunity to ask questions and receive answers about their training. These issues were: The meaning of ''understanding'; the meaning of ''ask questions and receive answers'; and whether specific training methods should be included in the rule.

Several commenters asked OSHA to explain what it meant by requiring training to be provided ''in language the employee understands'' (see, *e.g.*, Exs. 30–3826, 32–198–4, 30–3686, 30–3686, 30–3765, 32–339–1, 30–1091). Commenters were concerned that, despite their best efforts, some employees might not understand the training well enough to ''pass'' the test if CSHOs asked them questions (see, *e.g.*, Exs. 30–429, 30–494, 30–1090, 30–3122, 30–3557, 30–3593, 30–3781). These employers fear that they would be vulnerable to citation and penalty in such a circumstance. Commenters also interpreted OSHA's ''in language the employee understands'' terminology to mean that they would have to test employees to ensure adequate comprehension (see, *e.g.*, Ex. 30–3557). Another commenter specifically suggested that the final rule require the employer to demonstrate that the employees had understood the training (Ex. 32–339–1).

Employers were also concerned about having difficulty finding good translations of training materials (see, *e.g.*, Exs. 30–4538, 30–240, 30–429, 30–1090, 30–3868). One commenter noted, however, that training materials in Spanish could be obtained from the Labor Occupational Safety and Health Program at the University of California in Los Angeles (Ex. 30–4538). Some employers understood the proposed ''in language the employee understands'' terminology as meaning that they would have to train in each of the languages native to their workforce (see, *e.g.*, Exs. 30–240, 30–429, 30–1090, 30–3336, 30–3557), and expressed concern about the potential costs of such a requirement (Ex. 30–3868).

One commenter (Ex. 30–3336) stated that some companies in their industry had employees on the payroll who spoke 12 different languages; this commenter understood the proposal as requiring native speakers in each of these languages to be available to receive and answer questions on the content of the training and the ergonomics program. Moreover, this commenter argued that OSHA's ''multi-lingual'' training requirement presented an even greater problem for their industry because it had a history of employing ''mentally challenged'' individuals (Ex. 30–3336).

In response to these comments, OSHA reiterates that the final rule does not require employers to present training in the native languages of the employees working in the establishments. In many workplaces, although employees many have different ''first'' languages, they understand English or another language well. The rule merely requires that the employer provide the training in a language the employee *understands*. OSHA does not believe that this will be difficult, because employers are already communicating with their employees about safe working procedures, tool and equipment care, project requirements, work schedules, and dozens of other items of daily importance to workplace operation and productivity. In other words, training is just another form of communicating important information to employees, a process that is going on in all U.S. workplaces at the present time. As to the comment about the difficulty of complying with the rule in workplaces that employ individuals with mental disabilities (Ex. 30–3336), OSHA can only emphasize that the same techniques employers use to transmit other essential workplace information to these individuals can be used to provide the training required by the standard.

The final rule also does not require employers to test employees' understanding or comprehension of the training given. However, employers are free to do so if they wish, and OSHA is aware that many employers do evaluate the effectiveness of their training immediately or soon after it is given. Thus, although the training paragraph does not require employee testing, employers who wish to have some way of ensuring that their employees understand the training content may establish any system that works for them. Employers are required by the standard to evaluate the training component of their programs when they do their periodic evaluations to ensure effectiveness.

Some commenters (see, *e.g.*, Exs. 30–4538, 30–3686, 32–339–1) recommended that the final rule's training requirements be revised to be more consistent with those of other OSHA standards, such as the Bloodborne Pathogens rule (Exs. 32–4538, 32–339–1), the Process Safety Management standard (Ex. 32–339–1) or the Hazardous Waste Operations and Emergency Response standard (Ex. 30–3686). OSHA believes that the final rule's requirements, in paragraph (t)(3), that the training be in language the employee understands and that employees be permitted to ask questions and receive answers will together achieve the objective desired by these commenters, *i.e.*, assurance that employees understand the training thoroughly.

Several commenters asked OSHA to clarify the phrase ''ask questions and receive answers'' (see, *e.g.*, Exs. 30–3826, 32–198–4, 30–3686, 30–376). These commenters wanted clarification about the methods OSHA requires them to use to accomplish this (see, *e.g.*, Exs. 30–3765, 30–3826). Other commenters recommended that the rule specify that employees be permitted to ask questions and receive answers promptly even if questions occur to them after the training session is over (see, *e.g.*, Exs. 30–2116, 30–2809, 30–2825, 30–2847, 30–3001, 30–3033, 30–3034, 30–3035, 30–3258, 30–3332, 30–4159, 30–4536, 30–4546, 30–4547).

Some commenters suggested that specific training techniques to be included in the rule. Suggestions included:

• Allow the use of electronic media, telephone reviews, and videos (see, *e.g.*, Exs. 30–3826, 30–3765, 30–434, 30–3392).

• Require that training be provided in a supportive atmosphere that encourages discussion of concerns with respect to MSD-related working conditions and encourages opportunities for questions (Ex. 30–3686).

• Require training to be administered ''live''; prohibit written training (Ex. 32–198–4).

A commenter argued for the need for live training as follows:

> Employers often do not know at what level their employees are reading and comprehending. Workers are generally reluctant to share information about their literacy limitation (Sarmiento and Kay, ''Workers Centered Learning,'' 1990). It is estimated that between 45%–50% of adults in America struggle due to some limitations in their literacy and/or language proficiency (which result in limitation of ''understanding'' or ''reasoning''), according to ''Adult Literacy in America'' in publications of the U.S. Department of Education (1993). In addition, many of those functioning at a limited literacy level don't see themselves as having these limitations (Ex. 32–198–4).

The same commenter recommended methods such as visual aids, discussion and problem solving, and small group ''hands-on'' sessions, and noted that workers are more likely to trust the employers' programs and develop confidence if these more oral training methodologies are implemented (Ex. 32–198–4).

In response to these comments, OSHA restates the position it has taken consistently in other standards: OSHA's objectives are to require employers to provide basic training in ergonomics, to ensure that all trained employees understand the training, and to permit employees to ask questions if they need further information. The Agency does not dictate the methods that employers choose to achieve compliance with these requirements. Properly trained employees will be sufficiently informed to recognize the signs and symptoms of MSDs and the value of reporting them early, to identify MSD hazards in their jobs, to know how to use and evaluate the control measures that the employer implements to reduce those hazards, and to work in ways that will reduce the risks in their jobs. The standard also does not state how long the training must last and when the question and answer periods must occur; instead, OSHA is leaving such things to the employer's discretion.

Paragraph (u)—What Must I Do To Make Sure My Ergonomics Program Is Effective?

The intent of the provisions of the Program Evaluation paragraph of the final Ergonomics Program standard is to require employers to evaluate their ergonomics program to ensure that it is effective. Good management, as well as common sense, suggest that periodic review of a program's effectiveness is necessary to ensure that the resources being expended on the program are, in fact, achieving the desired result and that the program is doing so in an efficient way. Program evaluation is a tool that can be used to ensure that an ergonomics program is appropriate for the specific MSD hazards in the employer's problem jobs and that the program is achieving desired results.

OSHA has long considered program evaluation to be an integral component of programs implemented to address health and safety issues in the workplace. For example, the Ergonomics Program Management Guidelines for Meatpacking Plants (''Meatpacking Guidelines'') recommend regular program review and evaluation (Ex. 2–13). These guidelines suggest that procedures and mechanisms be developed to evaluate the ergonomics program and to monitor progress accomplished. Program evaluation is described in the Meatpacking Guidelines as a program component whose use reflects both management commitment and employee involvement. OSHA's 1989 voluntary Safety and Health Program Management Guidelines also recommend regular program evaluation as an integral program component (Ex. 2–12). Further, OSHA's Voluntary Protection Programs (V.P.P.) and Consultation Program require periodic evaluations of an employer's safety and health program, including that portion of the program addressing ergonomic issues.

The proposal contained a ''basic obligation'' section that merely summarized the proposed program evaluation provisions. The proposed basic obligation section also stated that employers were to evaluate their ergonomics program periodically, and at least every 3 years, ''to ensure that it is in compliance with this standard.'' Because the basic obligation sections of the proposed standard led to confusion and were not helpful, OSHA has not included them in the final rule. Since the basic obligation section only summarized the proposed program evaluation requirements, comments on that section are discussed below, in connection with the proposed requirement to which they refer.

The proposed rule contained provisions requiring employers with programs to review them periodically to ensure their effectiveness; identified the procedures employers were required to follow when conducting evaluations; proposed that evaluations be conducted as often as needed and at least every 3 years; and proposed that program deficiencies identified during the evaluation be corrected promptly. The final rule's program evaluation provisions have been revised to reflect comments received, but are generally similar to those proposed.

Paragraph (u)(1) of the final rule provides for the frequency of required program evaluations. The methods and procedures employers are required to use in such evaluations are included in paragraph (u)(1)(i) through (iv). Provision is made for other events that may trigger program evaluations at more frequent intervals in paragraph (u)(2). In addition, the prompt correction of any deficiencies identified during the evaluation is covered in final rule paragraph (u)(3). The following discussion presents OSHA's reasons for including revised program evaluation provisions in the final rule, and summarizes the comments the Agency received on the proposed program evaluation requirements.

Paragraph (u)(1)—Frequency of Program Evaluations

OSHA received many comments (see, *e.g.,* Exs. 30–240; 30–1671; 30–3860; 500–71–86; 500–137; 30–3686; 32–210–2; 32–85; Tr. 8982; 30–2116; 30–2809; 30–2825; 30–2847; 30–3258; 30–3035; 30–3001; 30–3033; 30–3034; 30–4159; 30–4534; 30–4536; 30–4800; 30–4776; 30–4546; 30–4547; 30–4548; 30–4549; 30–4562; 30–4627; 30–3332; 30–3259; 30–4801; 30–3898; 30–4270; 30–4498; 30–3813 ; 500–33; 30–3745; 30–3765; 30–3368; 30–4713; 30–4046; 30–4247) on the proposed frequency of ergonomic program evaluations, as well as on the events that should trigger them. A few commenters (see, *e.g.* Exs. 30–240, 30–1671, 30–3860, 500–137) agreed with OSHA's proposed 3 year time frame, while others stated that they believed a 3-year interval was too long and that program evaluations should take place periodically and at least annually (see, *e.g.,* Exs. 30–3686; 32–210–2; 32–85; and Tr. 8982).

As mentioned above, OSHA received many comments (see, *e.g.,* Exs. 30–2116; 30–2809; 30–2825; 30–2847; 30–3258; 30–3035; 30–3001; 30–3033; 30–3034; 30–3686; 30–4159; 30–4534; 30–4536; 30–4800; 30–4776; 30–4546; 30–4547; 30–4548; 30–4549; 30–4562; 30–4627; 30–3332; 30–3259; 30–4801; 30–3898; 30–4270; 30–4498; 31–242; 32–210–2; 500–71–86) stating that program evaluations should take place at least annually. These commenters generally argued, in the words of Greg Wyatt, an engineer who suffers from a repetitive stress injury and who offered comments as an individual, that ''the ergonomics program should be evaluated regularly (at least once a year) because it is easier and more cost effective to fix deficiencies early during the implementation phase'' (Ex. 30–3035). In a comment that pertains to all workplaces, the United Mineworkers of America agreed, ''Routine audits, no less frequently than once each year, should be performed of the entire workplace and problem areas reported to the appropriate company representative for immediate action'' (Ex. 500–71–86).

The need for evaluations at a minimum frequency of less than 3 years was addressed by several commenters (see, *e.g.,* Exs. 30–2116; 30–2809; 30–2825; 30–2847; 30–3258; 30–3035; 30–3001; 30–3033; 30–3034; 30–3686; 30–4159; 30–4534; 30–4536; 30–4800; 30–4776; 30–4546; 30–4547; 30–4548; 30–4549; 30–4562; 30–4627; 30–3332; 30–3259; 30–4801; 30–3898; 30–4270; 30–4498; 32–210–2; 32–111–4; 32–229; 30–4247), who pointed out that workplace changes that adversely affect the functioning of a particular element of the program or of the program as a whole can occur in the interval between periodic evaluations (or ''regularly scheduled'' evaluations). For example, the United Steelworkers of America (UOWA) agreed that employers should evaluate their ergonomics programs at least every 3 years but asked OSHA to include in the final rule requirements that would trigger evaluations at more frequent intervals as well. ''OSHA should provide additional specific requirements for the employer to respond to concerns raised by workers between evaluations. For example, employers should review health and safety committee minutes to determine if ergonomic concerns were identified, [and] then they should verify that those concerns have been promptly addressed or address them at that time'' (Ex. 32–111–4).

From a somewhat different perspective, Organization Resources Counselors, Inc. (ORC) (Ex. 30–3813) and Edison Electric Institute (EEI) (Ex. 500–33) asked that the standard's language be changed to reflect their belief that a requirement to evaluate an ergonomics program both periodically and every three years was excessive. Both commenters agreed that the employer was in the best position to determine how often the ergonomics program at a particular worksite needs to be evaluated to ensure its effectiveness. However, in ORC's words, ''it is not reasonable that the standard should require both periodic evaluation as well as an evaluation every three years.'' These commenters urged OSHA to require employers to evaluate their ergonomics programs periodically, ''and/or'' at least every 3 years.

Another rulemaking participant, the National Soft Drink Association (NSDA) (Ex. 30–368) questioned whether performance of a program evaluation every 3 years also would satisfy the proposed requirement for periodic evaluations. Because, NSDA believes that the two provisions are duplicative, it recommended that the term ''periodic'' be eliminated. The Dow Chemical Company (Ex. 30–3765) also opposed the ''at least every 3 years'' language, on the grounds that industry should be able to decide if and when periodic evaluations should be carried out but agreed that periodic reviews are necessary: * * * review on a periodic basis is necessary, especially * * * for dynamic workplaces with continuous turnover, process changes, etc.'' The National Telecommunications Safety Panel (Ex. 30–3745) agreed, saying the proposed rule's prescribed frequency presented particular problems for them because of their members' geographic sweep and rapidly changing workplaces and that [determining] ''program evaluation frequency * * * [should be] the sole responsibility of the employer.''

A few commenters (see, *e.g.,* Exs. 30–4713 and 30–4046) stated that the proposal's requirements for program evaluation were excessive: ''* * * a complete evaluation, as required by the rule, cannot be realistically performed 'periodically,' as that term is defined.''

A number of commenters who have themselves experienced MSDs (see, *e.g.,* Exs. 30–2116; 30–2809; 30–2825; 30–2847; 30–3258; 30–3035; 30–3001; 30–3033; 30–3034; 30–3686; 30–4159; 30–4534; 30–4536; 30–4800; 30–4776; 30–4546; 30–4547; 30–4548; 30–4549; 30–4562; 30–4627; 30–3332; 30–3259; 30–4801; 30–3898; 30–4270; 30–4498) also urged OSHA to require in the final rule that ''every time an employee reports persistent MSD symptoms or an MSD injury, Job Hazard Analysis and Control must be performed, and the ergonomics program must be re-evaluated.'' In the view of these commenters, every report of an MSD injury or persistent MSD symptom points to a deficiency in the ergonomics program that must be evaluated and corrected. OSHA agrees with these commenters that significant changes in workplace conditions, such as the introduction of a new process; changes in management or supervisory personnel, procedures, or policies; or changes in the form or intensity of employee involvement, can affect the functioning of the program substantially and thus may necessitate an evaluation of particular program elements or of the program as a whole.

However, the Agency has chosen not to shorten the minimum interval between program evaluations to once a year from every three years because such a requirement would prove to be too burdensome if imposed on all of industry. Such a frequency would deprive employers of the flexibility which was OSHA's goal in drafting the program evaluation requirements, given the diversity of workplaces covered by this rule.

OSHA also is not persuaded that it would be appropriate to require employers to evaluate their programs every time an MSD incident occurs or an ergonomic concern is expressed, as some commenters urged the Agency to do. Such a requirement would precipitate constant evaluations for employers with large workforces, where the incidence of MSD injuries is often high. OSHA does not expect that the program mandated by the standard will eliminate MDSs in the workplaces covered by the standard; indeed, as the discussion in Section VI of this preamble makes clear, OSHA is projecting that, on average, the standard will prevent about 50% of MSDs in such workplaces. Further, the Agency believes that employee concerns about ergonomics will be addressed regularly as a result of the standard's requirements for prompt responses to employee concerns and regular employer/employee communications about workers' concerns.

After a review of the evidence in the record on the frequency of program evaluations, the final rule requires them when there is reason to believe that the program is not functioning properly, when changes have occurred that may have increased employee exposure to MSD hazards, and at least once every three years. The final rule's requirements are essentially similar to those proposed, although they are somewhat more specific. OSHA's reasons for retaining provisions for program evaluation that require such evaluations at least once every 3 years and at other times if workplace conditions warrant them, are: (1) the diversity of conditions in the workplaces covered by the rule demands the combination of specificity and flexibility provided by the provisions in paragraphs (u)(1) and (2) all programs need to be evaluated at least once every 3 years to ensure that they are functioning optimally and meeting the needs of the organization over time.

Paragraph (u)(2)—Steps Involved in Program Evaluation

In the proposed section titled ''What must I do to evaluate my ergonomics program?'', the proposed rule stated that program evaluation goes beyond a mere inspection or audit of problem jobs. The final rule, at paragraphs (u)(2)(i), (ii), (iii) and (iv), contains similar requirements. For example, the proposed rule would have required employers to consult with employees in problem jobs to assess their views about program effectiveness and identify program deficiencies, paragraph (u)(2)(i) of the final rule requires employers to consult with employees, ''or a representative sample of them,'' about program effectiveness and any problems with the program. Paragraph (u)(2)(iii) requires employers to evaluate the elements of a program to ensure it is functioning effectively; this language is essentially unchanged since the proposal. The proposal would have required employers to carry out evaluations to ensure that the program was ''eliminating or materially reducing'' MSD hazards, while the final rule at paragraph (u)(2)(iii) requires the employer to assess whether MSD hazards are being identified and ''addressed.'' The final rule adds, at paragraph (u)(2)(iv), a requirement that employers use the evaluation as an opportunity to assess whether the program as a whole is achieving positive results. OSHA includes examples of measures of effectiveness, such as reductions in the number or severity of MSDs, increases in the number of jobs in which ergonomic hazards have been controlled, reductions in the number of jobs posing MSD hazards to employees, or any other measure that demonstrates program effectiveness.

An adequate evaluation asks questions of employers at all levels of the organization to determine whether the required ergonomics program elements have been adequately implemented and whether they are integrated into a system that effectively addresses MSDs and MSD hazards. Examples of questions an evaluation is designed to explore are:

—Has management effectively demonstrated its leadership?
—Are employees actively participating in the ergonomics program?
—Is there an effective system for the identification of MSDs and MSD hazards?
—Are identified hazards being controlled?
—Is the training program providing employees with the information they need to actively participate in the ergonomics program?
—Are employees using the reporting system?
—Are employees reluctant to report MSDs or MSD hazards because they receive mixed signals from their supervisors or managers about the importance of such reporting?
—Is prompt and effective MSD management available for employees with MSDs?

OSHA finds that these questions, which were included in the proposal, continue to be appropriate points for program evaluations to address. The comments OSHA received on the proposed requirements for conducting evaluations addressed the following topics: the vagueness of the proposed terms used; the inclusion of core elements in the program required by the standard and in the standard's requirements for evaluation; the need for OSHA to specify measures of effectiveness for employers to rely on; the statement in the basic obligation section of the proposed rule that programs should be evaluated to ensure that they are in compliance with the standard itself; who should carry out program evaluations; the records to be reviewed in a program evaluation; and the extent of the recordkeeping required by this provision of the standard. The comments OSHA received on each of these topics are discussed below.

Vagueness of the rule's terminology: The Center for Office Technology (COT) complained that some of the terms used in the context of the proposed evaluation section were vague and ''subjective'' (Ex. 25–710). Specifically, COT pointed to the proposed requirement that evaluations be conducted ''as often as necessary'' (defined in the proposal as ''periodically'') as an example of the vagueness of the proposal's language. COT stated, ''* * * training and program evaluation must be conducted ''as often as necessary'' and the program must be ''appropriate'' to workplace conditions. How will compliance with these vague, undefined and subjective requirements be assessed?''

Inclusion of core elements in the program: The Forum for a Responsible Ergonomics Standard (Exs. 32–351–1 and 30–3845) and others (Exs. 30–574; 30–2773; 500–33; 30–4040) were critical of the proposed Ergonomics Program standard's requirement that employers include in their programs, and evaluate, six mandatory core elements. By mandating that ergonomics programs have a certain form, *i.e.,* have specific elements, instead of requiring only that the program be effective, OSHA was, according to the Forum, ''elevating form over function, divorcing its program from [what should be] the goal of achieving reduced MSD injuries and focusing instead on ensuring that programs fit a bureaucratic mold that is administratively simple.'' In other words, the Forum believes that the effectiveness of an ergonomics program should be the sole measure of its success in any evaluation. The Forum stated that the proposed approach to program evaluation could lead to ''the perverse possibility'' of an employer with a program that successfully reduces MSDs being cited for a violation of the standard merely because the program failed to include a required program element.

Another commenter (Ex. 31–353) questioned how effective a program evaluation could be unless the rule required the effectiveness of each of the individual Ergonomic Program elements to be evaluated. ''Without determining the effectiveness of all the aspects of the program, an employer is wasting time and money, and effort.'' Similarly, the Department of Defense (Tr. 9085–9086) stated, ''If the evaluation is focused on the presence and function or process elements of the program then the standard should clarify the essential evaluation points for each program element.''

Compliance as a measure of effectiveness: The Dow Chemical Company (Exs. 30–3765 and 32–77–2) asked, ''Is the point of program evaluation to evaluate compliance with the standard or the program's 'effectiveness'? Or both?'' Dow's comment referred to a statement in the basic obligation section of the proposed rule to the effect that the program was to be evaluated to ensure its compliance with the standard. According to Dow, ''If OSHA maintains the requirement to evaluate 'effectiveness' of a program, then it should indicate the method an employer can use for measuring 'effectiveness.' '' A program may have all of the required elements and thus be in compliance with the rule, but not address all potential MSDs'' (Ex. 30–3765). The Association of Energy

Servicing Contractors (Tr. 15624) and others (Ex. 30–3839) agreed with Dow about the need for measurable criteria with which to gauge compliance with the standard.

Also commenting on this point was the Honorable Senator Christopher S. Bond, Chairman of the United State Senate Committee on Small Business, who submitted a study (Ex. 30–4334–4) carried out by the Regulatory Studies Program of Mercatus Center at George Mason University, entitled, ''Over Stressing Business: OSHA and Ergonomics.'' The study included the following statement: ''The draft rule requires employers to evaluate their ergonomics program according to both activity and outcome measures. Yet in the case of MSDs, neither activity nor outcome measures are likely to reflect program effectiveness.''

The final rule does not require employers to evaluate their programs for compliance with the standard, as proposed, because this statement confused commenters and is unnecessary. The final rule's requirements (paragraphs (u)(1)(ii) and (iii)) that employers ''evaluate the elements of the program to ensure they are functioning effectively'' and ''assess whether the program is achieving results'' will essentially ensure compliance with the standard and eliminate the confusion caused by the proposed statement. Further, as the Dow Chemical Company pointed out, programs may be effective even if they do not contain every sub-element of the OSHA standard; this is certainly the case with grand fathered programs that were put in place well before OSHA's standard was promulgated (Exs. 30–3765 and 32–77–2).

Measures of program effectiveness: Many commenters asked OSHA to identify measures of program effectiveness that the Agency believes are appropriate. For example, the Dow Chemical Company stated, ''If OSHA maintains the requirement to evaluate 'effectiveness' of a program, then it should indicate the method an employer can use for measuring 'effectiveness'. A program may have all the required elements and thus be in compliance with the rule, but not address all potential MSDs'' (Ex. 30–3765). The Oregon Building Industry Association (Ex. 30–562) and others (Exs. 30–368, 30–541, 30–627, 30–1697, 30–1717, 30–1355, 30–1545, 30–3783; 31–334: 32–210–2) raised the same issue, and the Oregon Association also asked, ''Would the occurrence of an injury allow the OSHA inspector to automatically qualify the program as not effective?'' (Ex. 30–562).

Organization Resources Counselors, Inc. (ORC) (Ex. 30–3813) voiced a somewhat different concern regarding the need for measures of effectiveness. ''OSHA expresses particular concern in the preamble that there is a need to assure that a demonstration of effectiveness does not mask under reporting of MSDs,'' they wrote. ORC agreed that this was a real concern and suggested that employers should be required to provide evidence that there is an effective early reporting mechanism in place as a part of their demonstration of program effectiveness. In response to the views of commenters, OSHA notes that the final rule identifies a number of measures of effectiveness, including reductions in the number or severity of MSDs, increases in the number of jobs in which ergonomic hazards have been controlled, reductions in the number of jobs posing MSD hazards to employees, or any other demonstrably appropriate measure of effectiveness, that OSHA believes are indicative of program effectiveness. This list of measures is not exhaustive; it is meant to be illustrative only. OSHA is aware that employers with successful programs use other measures, such as reductions in workers' compensation costs, increases in the number of early reports of MSD signs and symptoms, and increases in product quality, to evaluate the effectiveness of their ergonomics programs (DOD Tr. 3296–3297; OR Ex. 32–78–1 p.22; AFL–CIO Ex. 32–339–1–29; Library of Congress Ex. 32–339–1–33 p.143; Paper, Allied-Industrial, Chemical & Energy Workers International Union Local 1202 (PACE) Tr.11206; International Paper Ex. 32–61).

As one rulemaking participant, Organization Resources Counselors (ORC) (Tr. 4147) stated during testimony about the proposed rule, ''* * * there are many different ways that companies use to evaluate effectiveness. While they might all have common elements. . .they apply those elements in very different ways, depending on the circumstances, the nature of the work, the employees, and the nature of the workplace.'' In addition, OSHA does not believe that the ''occurrence of an injury'' automatically qualifies a program as ''ineffective,'' in the words of the Oregon Building Industry Association (Ex. 30–562). OSHA recognizes that, especially in large workplaces in industries with many problem jobs, MSDs may continue to occur. The final rule takes a comprehensive view of program effectiveness and emphasizes the importance of the essential elements of the program and their proper functioning. In response to ORC's comment about the importance of ensuring that early reporting is present, OSHA agrees that such reporting is essential to program effectiveness and has accordingly built several mechanisms that will ensure early reporting'work restriction protection, multiple HCP review, hazard information and reporting'into the final rule.

Who should conduct program evaluations?: The preamble to the proposal stated that program evaluations may be conducted by those responsible for carrying out the employer's program, but also noted that evaluations performed by persons who are not involved in the day-to-day operation of the program are often even more valuable because these individuals bring a fresh perspective to the task. They often can identify program weaknesses that those routinely involved in program implementation may fail to see (64 FR 65858–65859). OSHA received a number of comments addressing who should perform the required evaluations (Exs. 30–2809; 30–115; 30–2387; 30–3826; 32–339–1; 601–x–1587–2). One commenter cautioned that special care must be taken to ensure continuity within the program when outside entities perform successive program evaluations (Ex. 30–2809). This commenter stated, ''It is important to keep records from every evaluation of the ergonomics program so that mistakes are not repeated * * * if a different company performs the evaluation, lessons learned from the previous evaluation may not be recorded * * * It is also important to ensure that all ''action items'' (issues brought up during previous evaluations) are resolved and not ignored.''

The American Federation of Government Employees (AFGE) (Ex. 30–115) suggested that OSHA or some neutral third party was the appropriate entity for evaluating the ergonomics program because ''management should not have carte blanche to evaluate their own program.'' Similarly, the American Society of Safety Engineers (ASSE) (Ex. 601–x–1587–2) commented that the level of expertise needed to perform program evaluation/third party audits under this standard is outside that which many organizations are able to provide. Therefore, ''in order to meet the expected need of consultation services, OSHA should consider reviewing a system for voluntary third party audit and evaluations, and work with accredited private sector professional certification bodies, both public and private recognized registries, and membership organizations to ensure that consultants have an acceptable level of competence.''

The American Association of Occupational Health Nurses (AAOHN) (Ex. 30–2387) cautioned OSHA about the need to protect employee privacy during the collection and review of program records for evaluation purposes. The AAOHN pointed out that ''individuals who are not part of the day to day operation of the program can bring a fresh perspective, however in any evaluation, the employer should ensure that employees' privacy is protected.'' For example, the AAOHN noted that a co-worker brought in to evaluate a program must understand the need for confidentiality concerning her or his co-worker's personal health information, if such information is part of the program evaluation. OSHA agrees with the AAOHN that the privacy of employee medical and exposure records must be protected at all times, including during a program evaluation. These records are required to be handled at all times in accordance with 29 CFR 1910.1020, OSHA's Access to Employee Exposure and Medical Records standard.

In response to the views of these commenters, OSHA notes that the proposed rule did not specify who was to perform the required program evaluations; the final rule also does not limit the employer's choice of program evaluators. OSHA is aware that employers with effective programs rely on different individuals, both from within and outside their organizations, to perform this function and that the results of doing so are often excellent (see, *e.g.,* Exs. 32–339–1–53, 601–X–1711). Some programs, such as the one at General Motors, rely on trained employees in a Joint Ergonomics Team, consisting of union and management members, to conduct program evaluations (Ex. 32–339–1–53), while other companies, such as Halliburton, Inc. (Ex. 601–X–1711) rely on a Board Certified Professional Ergonomist or other outside expert or organization to carry out their program evaluation. OSHA does not agree either with those commenters who argued that employers are not choosing appropriate and qualified program evaluators or that the Agency should narrow the employer's discretion in this regard. OSHA remains convinced that different approaches are appropriate in different workplaces and that employers are best suited to decide who should conduct the required evaluations. The final rule, therefore, leaves the selection of evaluators to the employer.

Records review in the context of program evaluation: OSHA recognizes in the final rule, as it did in the preamble to the proposed rule (64 FR 65859), that the extent of the evaluation called for by the rule will vary from one workplace to another, based on the characteristics and complexities of the work environment. However, the basic tools of evaluation remain the same from workplace to workplace, even though their application may vary. These tools, which are basic to the evaluation of any safety and health program, include:

—Review of pertinent records, such as those related to MSDs and MSD hazards;
—Consultations with affected employees (including managers, supervisors, and employees) regarding the ergonomics program and its problems (if any); and
—Reviews of MSD hazards and problem jobs.

Examples of the records that are often included in such reviews include the following:

—The OSHA 200 log (if the employer is required to keep a log);
—Reports of workers' compensation claims related to MSDs;
—Reports of job hazard analyses and identification of MSD hazards;
—Employee reports to management of MSDs or persistent MSD signs or symptoms;
—Insurance company reports and audits about ergonomic risk factors or MSD hazards; and
—Reports about MSD hazards from any ergonomic consultants engaged by the employer.

Some employers, especially owners of very small businesses, may have few of these records and will, therefore have to rely on other, less formal, methods to assess effectiveness. Small employers generally place more emphasis on employee interviews and such approaches as surveys of MSD hazards and problem jobs when they perform ergonomics program evaluations. Records reviews can yield valuable information on the effectiveness of an ergonomics program when comparisons are made from year to year and trends are identified. For example, if an employer compares the list of MSD hazards identified during consecutive program evaluations and finds that the number of hazards has decreased over time, the employer may conclude that the program's job hazard analysis and control activities have been effective. Similarly, a reduction in the number of MSDs from year to year suggests that the program may be effective, although numbers alone sometimes can be misleading. However, program evaluation also must consider the accuracy and reliability of the records under review. For example, it is essential to be sure that the identified trends are real and not the product of under reporting, loss of interest in the program, or loss of attention to detail. For example, a downward trend in the number of MSDs or MSD hazards reported may indicate that employees are being discouraged from reporting or that the employees performing job hazard analysis and control are not doing an effective job because they are not adequately trained to do so.

OSHA received a variety of comments about records review in the context of program evaluation (Exs. 30–3765, 30–276; 30–546; 30–2846; 30–1726). For example, the Dow Chemical Company argued that the proposed requirement that employers evaluate different elements of the program would require them to gather records to support this effort and would thus impose an undue burden on certain employers. Dow argued, ''depending on the size and makeup of the workplace, a review of all the proposed records by each workgroup would add undue burden on each group'' (Ex. 30–3765).

Texas A and M University (Ex. 30–276) also found the records review associated with program evaluation potentially burdensome. ''Record keeping is not value-added for the employer or employees. It primarily benefits the regulatory overseer.'' ElectriCities of North Carolina Inc. (Ex. 30–546) agreed: ''[These sections] speak of compulsory Record keeping above and beyond the OSHA 200 log of recordable work place injuries and illnesses * * *''. The Manufactured Housing Institute (Ex. 30–2846) noted that ''Small business is already overwhelmed with paperwork requirements and OSHA should avoid adding to that burden.''

The University of Wisconsin Extension (Ex. 30–1726) asked OSHA to require that all MSD reporting forms be retained by employers for eventual program review. ''If a standard reporting form is required for all employees to report MSD problems, signs and symptoms, these forms should be retained and made part of the program review, to follow up each form filed during the program evaluation period.''

In response to these concerns about the recordkeeping burden associated with program evaluation records review, OSHA notes that the final rule does not mandate that employers review specific records when conducting their evaluations. In fact, the final rule does not mandate records review or require the development of new records of any kind. This preamble discussion on records review simply recognizes that reviewing records already maintained by the employer for other purposes is one way of getting the information needed to evaluate a program.

The Agency believes that employers are best able to determine which records in their workplace will provide the most valuable information for evaluation purposes. For example, in a very small firm that is not required to keep the OSHA 200 Log, the only records available for review may be employee reports of MSD incidents, workers' compensation claim information, and records of Quick Fix controls implemented; some workplaces may not even have these records. In most workplaces, however, employers will wish to review a variety of records to identify trends, evaluate the functioning of each program element, and assess the overall performance of the program. OSHA's approach is consistent with that taken by a number of employers who conduct evaluations of their ergonomics programs, in that it allows employers the latitude to decide how best to conduct evaluations of their workplaces. The United Technologies Corp. (Ex. 31–334) agrees that such flexibility is important: ''It is important to encourage creativity and innovation on the part of employers in meeting the requirements * * *''. This flexibility also means, of course, that employers such as The University of Wisconsin Extension (Ex. 30–1726) who wish to develop standardized MSD reporting forms to use for evaluation and other purposes are free to do so.

The proposal contained a requirement that program evaluation include consultations with employees, and the final rule also includes such a requirement. Affected front-line employees (or a sample of them), and their supervisors and managers, must be included in this process. Consultations with employees elicit information on how well the ergonomics program has been communicated to the people who rely on it the most.

Paragraph (u)(2)(ii) of the final rule requires employers to evaluate the elements of their ergonomics programs to ensure that each of the elements is working properly. If employees cannot explain what MSD hazards they are exposed to in the course of their work, do not know what steps their employer is taking to eliminate or control these hazards, are unclear about the procedures they should follow to protect themselves from these hazards, or do not understand how to report MSDs or MSD hazards, the hazard information and reporting and training components of the program are not working. If a supervisor is unclear about how to reinforce proper work practices, the management leadership and training components of the program are both likely to need improvement. Similarly, if managers are not aware of the MSDs and MSD hazards employees are reporting and what corrective actions are being taken, the management leadership and training components of the ergonomics program should be improved. Because interviews allow the program evaluator to assess how the elements individually and the program as a whole is actually working, there is no substitute for direct input from employees in the evaluation process.

Program evaluation also must include an assessment of MSD hazards and the extent to which they are being addressed (paragraph (u)(1)(iii)). This assessment is concerned not only with identifying MSD hazards but with identifying how well the ergonomic program is addressing them. If the program evaluation identifies jobs that have not been analyzed but exceed the Action Level, the job hazard analysis component of the program needs to be improved. In addition, if jobs with previously identified MSD hazards have not been corrected or prioritized for correction, the evaluator may conclude that the job hazard control component of the program is not effective. Likewise, if an MSD hazard is identified and controlled in a problem job in one part of the facility but the same job has not been controlled in another part of the facility, several program components may need attention: the management leadership component, which may have failed to coordinate and disseminate MSD hazard information throughout the facility, the training component, which may have failed to provide the employees performing the job hazard analyses with adequate training, and the control component, which may have failed to prioritize jobs appropriately for control.

Paragraph (u)(1) (i)–(iv) establishes the steps employers must follow to evaluate the effectiveness of their ergonomics programs. It answers the question, ''What must I do to make sure my ergonomics program is effective?'' This requirement describes the minimal evaluation procedures necessary to assess whether or not an ergonomics program is working as intended. Paragraph (u)(1) of the final rules reads as follows:

(1) You must evaluate your ergonomics program at least every three years as follows:

(i) Consult with your employees in the program, or a sample of those employees, and their representatives about the effectiveness of the program and any problems with the program;

(ii) Review the elements of the program to ensure they are functioning effectively;

(iii) Determine whether MSD hazards are being identified and addressed; and

(iv) Determine whether the program as a whole is achieving positive results, as demonstrated by such indicators as reductions in the number and severity of MSDs, increases in the number of problem jobs in which MSD hazards have been controlled, reductions in the number of jobs posing MSD hazards to employees, or any other measure that demonstrates program effectiveness.

Paragraph (u)(1)(i) of the final rules requires employers to ''consult with your employees in the program, or a sample of those employees, and their representatives about the effectiveness of the program and any problems with the program.'' Employee participation in the ergonomics program is critical for success, and the involvement of employees in program evaluation is just one more way that employees can take an active role in the program. The requirement that employers consult with employees regarding program evaluation is not unique to the final Ergonomics Program standard. OSHA recently promulgated a similar provision in the Respiratory Protection final rule (29 CFR 1910.134).

Employees in jobs that have been identified as problem jobs are in the best position to judge whether or not job hazard analysis and control measures are effectively reducing or eliminating MSD hazards. Perhaps even more importantly, these employees will be most knowledgeable about whether the implemented controls have introduced new, unintended MSD hazards to the job. By consulting with employees, employers also can have direct feedback on the effectiveness of other ergonomics program elements, such as opportunities for employee participation, hazard information and reporting, and training. OSHA is aware that employers sometimes act in good faith to implement ergonomics program elements, but that the actual result experienced by employees can differ markedly from the intention. Thus, by checking directly with their employees, employers can be sure that their ergonomics program resources are being effectively invested.

Two rulemaking participants commented that the proposed provision on employee consultation did not require consultations with anyone other than employees in problem jobs or allow the employer to select a subset of employees with whom to consult. The Department of Defense (Ex. 30–3826) commented that, for some employers, such as large companies, branches of the military, etc., the requirement to consult with employees could be interpreted to mean consultation with tens of thousands of employees. As a result, DOD requested that the requirement be changed in the final rule to allow for representative sampling of employees. In addition, both the DOD (Ex. 30–3826) and the AFL–CIO (Exs. 32–339–1; 500–218) commented that OSHA had neglected to include employee representatives in the proposed consultation process. The AFL–CIO suggested (Ex. 32–339–1) that this provision of the final rule ''should be modified to provide for consultation with the employee representative, in addition to employees in problem jobs. This modification is consistent with the requirement of [the proposed employee participation provision] which calls for both employees and employee representatives to be involved in all aspects of the program.''

After reviewing the record on these points, the Agency has revised paragraph (u)(1)(i) of the final rule to reflect the concerns of larger employers and to allow them to consult with employees in the program, or ''a sample of those employees'' about the effectiveness of the program and any problems with it. In addition, the final rule states clearly that designated employee representatives are to be involved in the consultation process (paragraph (u)(1)(i)). Further, employers are, of course, free to involve other employees in the consultation process if they wish to do so; however, OSHA is not requiring that employees other than those in problem jobs be consulted as part of the evaluation process.

Another concern raised by the Dow Chemical Corp. (Ex. 30–3765) was its interpretation that OSHA was attempting in the preamble for this proposed section to mandate the questions employers must ask in conducting an evaluation: ''Dow does not believe that OSHA should mandate the specific questions each employer must ask employees during this review, which it seemingly tries to do in the preamble at page 65858.'' Dow went on to say, ''Scripted questions may not adequately uncover issues or concerns and, from the perspective of the employee, may sound more like an interrogation than a fruitful dialogue.'' OSHA does not intend the discussion questions included in the preamble to be mandatory. They are presented to provide employers, and particularly smaller employers who are less likely than a company like Dow to be experienced in program evaluation, with ideas about the kinds of topics an evaluator might find useful when consulting with employees.

Some rulemaking participants (Exs. 30–494, 30–3745, 30–3723, 32–351–1, 30–4467) argued that employee participation in the evaluation process might be problematic. They evidently believe that requiring employers to consult with employees in problem jobs could subject the employer to citations. For example, the Forum for a Responsible Ergonomics Standard (Ex. 32–351–1) commented, ''If an employee deems the program ineffective, but the employer disagrees and implements no measures to improve effectiveness, the proposal appears to grant OSHA discretion to cite the employer for non-compliance.'' Morgan, Lewis & Bockius LLP (Ex. 30–4467) also raised concerns about employee participation in developing, implementing and evaluating the employer's ergonomics program: ''The latter is the most troublesome; employers could conceivably receive citations by virtue of a compliance officer's subjective determination that employees were not allowed to evaluate every aspect of the program. Moreover, if employees' suggestions for a program are rejected, the employer arguably could be said to have unlawfully limited employee participation in the ''development'' of a program. (Ex. 30–4467). ''

Three other commenters, the Salt River Project (Ex. 30–710), the Integrated Waste Services Association (Ex. 30–3853), and Southern California Edison (Ex. 30–3284), argued that the proposed provision to consult with employees during evaluations was too open to subjective interpretation: ''The final standard should make clear that the employer is not required to act on a recommendation from employees if the employer can document that the recommendation is without merit'' (Ex. 30–3284).

In response to these comments, OSHA notes that, in the Agency's experience, employee input is invaluable; employees are the best source of information on how a program is working in practice. However, employers are expected to use their judgment and to assess the value of any information they receive in the course of an evaluation, whether from a records review or employee consultations. Weighing input from many sources is standard management practice, and the rule anticipates that employers will continue to use their judgment in these matters. Further, OSHA intends employee participation in the ergonomics program to be active and meaningful, but this does not mean, as Morgan, Lewis & Bockius suggest, that they must be allowed to evaluate ''every aspect of the program'' (Ex. 30–4467).

Paragraph (u)(1)(ii) of the final standard requires employers to ''review the elements of the program to ensure they are functioning effectively.'' This requirement is nearly identical to the corresponding provision proposed. OSHA received a few comments on this proposed provision (see, *e.g.,* Exs. 30–3031, 30–3813, 30–4334). Tesco Drilling Technology Inc. (Ex. 30–3031) stated: ''If OSHA does in fact believe that employers are best able to determine evaluation criteria, and that employers should be able to define ''functioning properly,'' why is OSHA proposing this cumbersome standard to begin with? If there is no specific evaluation criteria or goal in each element, how can a compliance officer issue a citation for noncompliance in any portion of the program?'' Organization Resources Counselors, Inc. (ORC) (Ex. 30–3813) stated that the phrase ''functioning properly'' was vague, and comments received from Senator Bond, Chairman of the United States Senate Committee on Small Business (Ex. 30–4334), agreed with those of ORC: ''For an employer to evaluate its ergonomics program, it is to ''evaluate the elements of [its] program to ensure they are functioning properly; and evaluate the program to ensure it is eliminating or materially reducing MSD hazards * * * The use of these terms, and others, throughout the proposed standard means that employers will be left to their own instinct and resources to decide whether they have met the obligations and gone far enough.''

OSHA's reason for including this provision in the final rule is that evaluations of individual elements and their functioning often reveal program deficiencies that are undermining program effectiveness but could be difficult to detect if the employer only evaluated the program as a whole. For example, if employees are not reporting MSD hazards, it may mean that the management leadership and training components are not working properly. The final rule thus continues to require that employers evaluate each program element as well as the program as a whole. How this is done is left to employers, because the records, methods to be used, and cultures of workplaces differ markedly and no one approach is appropriate for all. The final rule does not include specific effectiveness measures for each element of the program, because these would vary extensively from one workplace to another. However, as commenters recommended, the final rule does include examples of effectiveness measures that are useful in evaluating the effectiveness of programs as a whole.

Paragraph (u)(1)(iii) of the final rule requires employers to ''determine whether MSD hazards are being identified and addressed.'' The primary purpose of implementing an ergonomics program is the identification and control of MSD hazards. OSHA expects employers to establish evaluation criteria to assess the success of their program in meeting this goal. There are a wide variety of methods available to employers, ranging from a simple count of the number of problem jobs controlled to more sophisticated analyses, such as year-to-year trend analyses.

Again, OSHA finds that employers are best able to determine the specific evaluation criteria that will most effectively tell the story of their efforts to identify and address MSD hazards. Commenting on the corresponding proposed paragraph, which would have required employers to evaluate their program to ensure it is ''eliminating or materially reducing'' MSD hazards, Milliken & Company (Ex. 30–3344) and others (Exs. 30–3749, 30–4674) argued that the proposed provision would require an evaluation to ensure that the program is eliminating MSD hazards, when a better measure might be the extent to which the program is reducing the incidence of MSDs. Nucor Corporation and Vulcraft-South Carolina (Exs. 30–3354, 30–3848, 30–4799, 30–4540, 601–x–1710) asked OSHA to add ''to the extent feasible'' to this provision on the grounds that doing so ''would keep the proposed regulation consistent in its requirements throughout all elements of an ergonomics program.''

The Dow Chemical Co. (Ex. 30–3765) asked OSHA to modify this paragraph in the final rule by adding specific language at the end of the paragraph to read, ''or maintaining the risks at an acceptable level.'' In Dow's view, such a change would make it clear that instituting the same ''fix'' across the board may not eliminate all MSD injuries. Dow also was unclear about what the Agency meant by ''materially reducing'' MSD hazards.

The National Telecommunications Safety Panel (Ex. 30–3745) expressed similar concerns about the proposed phrase ''eliminating or materially reducing MSD hazards.'' The Panel argued that this language was misleading because, ''some MSDs exist epidemiologically in any workplace.'' SBC Communications Inc. (Ex. 30–3723) urged OSHA to delete the term ''eliminating or materially'' from the final rule because its use failed to recognize ''that some MSDs may exist epidemiologically in any workplace and that the program [envisioned by the standard] is realistic and performance-based.''

Footwear Industries of America Inc. (Ex. 30–4040) commented that the inclusion of the proposed ''eliminating or materially reducing'' phrase suggested that ''employers will meet their obligations if they select and implement the controls that a reasonable person would anticipate would achieve a material reduction in the likelihood of injury. '' However, according to this commenter, ''the ''reasonable person'' standard is hardly a bright-line test and provides excessive enforcement discretion to OSHA inspectors when determining compliance.''

OSHA has revised many provisions of the final rule in response to comments received and data submitted to the record. One of the more important changes is the revision to the language of paragraph (k), which tells employers what they must do to achieve compliance with the final rule's control requirements. The final rule no longer uses the phrase ''materially reduce,'' and paragraph (u)(1)(iii) therefore has been revised as well. The language of this provision now requires employers to ''determine whether MSD hazards are being identified and addressed.'' OSHA believes that this language is responsive to the concerns of those employers who interpreted the proposed language to mean that all MSD hazards had to be eliminated before an ergonomics program could be judged effective. The final rule, at paragraph (k), makes clear that OSHA will consider an employer to be in compliance with the standard's control requirements when it has implemented controls meeting any of the endpoints identified in that paragraph. There are clearly many ways to assess whether the program is identifying MSD hazards and dealing with them appropriately, as discussed above, and any method that is appropriate and accurate in making this assessment is acceptable to OSHA.

A number of rulemaking participants (Exs. 32–182, 32–111–4, 30–167, 30–3826, 32–210–2, 32–85–3, 30–3686, 30–3826, Tr. 9088, Exs. 30–3284, 30–240, Tr. 16578, Exs. 32–339–1, 500–218, 31–307, 30–3860, Tr. 8982, Tr. 4372, Exs. 30–1726, 30–1726) commented that OSHA would clarify the proposed evaluation requirements significantly if it developed guidance materials and model evaluation tools for employers. For example, Organization Resources Counselors (ORC) (Ex. 30–3813) made comments that were representative of those of the above group when it asked OSHA to include a non-mandatory appendix of types of performance measures and approaches that OSHA would consider appropriate. In addition to the measures of effectiveness mentioned by OSHA in the proposed preamble, such as decreases in the numbers or rates of MSDs and decreases in severity, ORC suggested a few others: ''Measures might include reduced workers' compensation claims for MSDs, use by the employer of periodic symptoms surveys and other indicia of effective, early reporting, or demonstration that risk factors have been reduced and/or tools and equipment have been modified.''

Two other commenters, the American Federation of State, County and Municipal Employees (AFSCME) (Ex. 32–182) and the United Steelworkers of America (Ex. 32–11–4), argued that such tools were necessary. They criticized the proposed evaluation provisions in general, because they failed to provide any criteria to aid employers in determining if their ergonomics programs were effectively eliminating or materially reducing MSDs. The American Association of Occupational Health Nurses (AAOHN) (Exs. 30–3686, 30–2387) also urged OSHA to assist employers by providing standardized evaluation forms.

OSHA agrees that providing employers with evaluation tools and forms would be helpful to employers, employees, and OSHA Compliance Officers. In the period between publication of the final rule and the compliance dates for program evaluation, the Agency plans, if resources permit, to develop and disseminate such materials.

AM Moving and Storage Association (Ex. 500–82) argued that the standard as a whole would be infeasible for its member companies: ''if it is not feasible for movers to implement controls that would eliminate and materially reduce MSD hazards, then it is equally impossible for moving and storage companies to monitor and track the progress of the proposed ergonomics program.'' OSHA is not, in this standard, requiring employers to implement infeasible controls or to reach infeasible hazard control endpoints. Instead, OSHA is requiring employers to take reasonable measures to protect their employees from MSD hazards. OSHA expects that moving companies also will find effective ways of reducing the number and severity of their MSD hazards.

The Union of Needletrades, Industrial and Textile Employees (UNITE) (Ex. 32–198–4) argued that the proposed evaluation section would be ineffective. They commented that the proposed evaluation requirements overall were too narrow and ''must be expanded to determine actual effectiveness of the existing program.'' OSHA agrees, and has expanded the final rule's evaluation requirements to include a requirement that employers assess their programs using indicators of effectiveness, such as reductions in the number, rate, or severity of MSDs. OSHA believes that the final rule's combination of qualitative and quantitative approaches to program evaluation will ensure the effectiveness of the programs implemented to comply with this rule.

Paragraph (u)(2)—Program Evaluations at More Frequent Intervals Triggered by Events

Paragraph (u)(2) of the final rule requires an employer to evaluate the program, or a relevant part of it, when the employer has reason to believe that the program, or an element of the program, is not functioning as intended; when operations in the workplace have changed in a way that is likely to increase employee exposure to ergonomics risk factors and MSD hazards on the job; and, at a minimum, once every three years. Thus, the final rule retains the minimum 3-year evaluation frequency proposed but provides greater specificity than did the proposal about the events that trigger evaluation at more frequent intervals.

The proposed language on the frequency of program evaluation, which required employers to evaluate their programs ''periodically, and at least every 3 years,'' was performance-based rather than specific because of the diversity of workplaces covered by the rule. OSHA defined periodically in the proposal as a process or activity that is ''performed on a regular basis that is appropriate for the conditions in the workplace'' and ''is conducted as often as needed, such as when significant changes are made in the workplace that may result in increased exposure to MSD hazards.'' Thus, the proposed provision on the frequency of required evaluations was designed to reduce unnecessary burdens on employers whose workplaces, for example, changed little over time, while ensuring that program evaluations, which are essential to program effectiveness, were conducted at some minimal frequency. The final rule reflects the same principles but has been revised to provide the additional specificity requested by commenters.

OSHA continues to believe, as explained in the proposal, that the employer is in the best position to determine how often the ergonomics program at a particular work site needs to be evaluated to ensure its effectiveness. A site undergoing process or production changes, for example, or one experiencing high turnover, may need more frequent evaluations than other, less dynamic, workplaces. Workplaces with these characteristics are addressed by final rule paragraph (u)(2), which requires employers faced with changes in operations that are likely to increase employee exposure to evaluate their programs when such changes occur. Similarly, an increase in the number or severity of MSDs in the workplace would suggest that a program evaluation is warranted. This situation is one that would be covered by paragraph (u)(2) of the final rule; such an increase clearly suggests that the program, or a part of it, has failed to operate properly. In work environments with a stable workforce and work operation, program evaluations conducted once every three years may be sufficient. For these workplaces, the minimum frequency required by paragraph (u)(1) may apply.

As noted in the proposal, current industry practice as to the appropriate frequency of ergonomics program evaluations in specific environments is available from other sources. For example, the Meatpacking Guidelines (Ex. 2–13) recommend semi-annual reviews by top management to evaluate the success of the program in meeting its goals and objectives. In addition, a wide range of companies with successful ergonomics programs evaluate these programs at regular intervals.

Paragraph (u)(3)—Correcting Program Deficiencies

Paragraph (u)(3) of the final rule requires employers to correct any deficiencies identified by the evaluation. It also requires that employers correct such deficiencies promptly. Deficiencies are findings that indicate that the ergonomics program is not functioning effectively because, for example, it is not successfully controlling MSD hazards or is not providing needed MSD management. OSHA requires employers to respond to deficiencies in the ergonomics program by taking actions such as: identifying corrective actions to be taken; assigning the responsibility for these corrective actions to an individual who will be held accountable for the results; setting a target date for completion of the corrective actions; and following up to make sure that the necessary actions were taken. In a very small workplace, of course, such detailed planning would likely not be necessary.

Some commenters, including Milliken & Company (Ex. 30–3344) and (Exs. 30–3749; 30–4674), stated that the proposed requirement to correct program deficiencies discovered during an evaluation would create a ''needless second tier of violations on top of the underlying substantive requirement that is not being met.'' Moreover, they argued that, ''the requirement to promptly take action to correct deficiencies does not provide sufficient latitude for employers to implement corrections within a time frame that will be reasonable in every case.'' Tesco Drilling Technologies (Ex. 30–3031) also expressed concern about an employer's liability once program deficiencies have been identified. Tesco asked, ''What are the criteria by which a compliance officer can issue a citation under this provision. * * * If a citation can not be issued, how can this be enforced? If it cannot be enforced, how can it be a rule?''.

In response, OSHA wishes to emphasize that its primary goal is to protect employees from MSD hazards, not to hold employers liable for ergonomics program deficiencies. OSHA expects that even the best programs will find deficiencies in their ergonomics program at one time or another. OSHA's concern is whether or not the employer has acted on the information obtained during the program evaluation and is taking steps to correct the problems identified. Employers who act in good faith to correct identified program deficiencies clearly will satisfy this requirement. However, employers who identify ergonomic program deficiencies through the evaluation process and then do not act on this information may not be in compliance with this requirement.

The final rule does not specify the time frame within which identified program deficiencies must be corrected. The Agency recognizes that the time needed to correct a program deficiency will vary according to many factors. For example, the following factors may influence an employer's response time:

—The nature of the MSD hazard;
—Previous attempts to correct the problem;
—The complexity of the needed controls;
—The expense of the needed controls;
—Whether the hazard is a higher or lower priority in the list of identified program deficiencies; and
—The expertise needed to control the hazard.

Some rulemaking participants (Exs. 30–3853, 30–3765, 30–710, 30–240) commented that OSHA was not clear about what kind of program deficiencies needed correction or what ''as quickly as possible'' meant. Edison Electric Institute's (EEI) comment (Ex. 30–3853) was representative of the views of those commenters concerned about the time frame for correcting deficiencies: EEI stated that the proposed requirement to correct ergonomics program deficiencies ''as quickly as possible'' was vague and unenforceable. August Mack Environmental Inc. (Ex. 30–240) stated that, in many cases, the responsibility for correcting deficiencies found will be transferred to a program administrator, who may be so overwhelmed with other duties, including those of the ergonomics program, that he or she may not be able to respond in a reasonable period of time. ''My concern is that a deficiency may be found and assigned to the program administrator who will work the problem into his or her overall priority system, so that it can be fixed,'' August Mack posited. ''However, if inspected in the meantime, OSHA will find that this is not responsive enough.''

Again, OSHA's aim in including program evaluation requirements in the final rule and in requiring deficiencies identified through evaluation to be corrected promptly is not to catch employers in violations but to ensure that the employer's ergonomics program is working correctly. If employers have identified deficiencies, corrected those that can be addressed quickly and easily, prioritized those requiring longer to correct, and are making reasonable progress in addressing prioritized deficiencies, they likely will be in compliance with these requirements.

The Dow Chemical Company (Ex. 30–3765) argued that the proposal was unclear as to what program deficiencies were being addressed. ''Dow simply does not understand whether the evaluation in this section is the same evaluation of the program required in other sections as an employer deals with identified problems or whether it is an evaluation of the program addressing every element of this regulation. If it is the first case, then the section is redundant and should be removed. If it is the latter case or both, then the Preamble and section should be rewritten to clearly explain this.'' OSHA is unclear about the meaning of Dow's comment, but believes that the final rule's clear requirements for program evaluation will shed light on the issues of concern to them.

Dow (Ex. 30–3765) also voiced concern that the proposed evaluation section seemed, in their opinion, to unfairly shift the burden of correcting program deficiencies to the employer without considering the employee's contribution to such deficiencies. Dow argued that the burden of correcting deficiencies should not be placed completely on the shoulders of the employer. ''Because ergonomics is focused on how an individual interacts with his or her workplace, Dow believes that the employee must have some responsibility for making appropriate changes in their activities.'' Dow suggested that OSHA include an ''Employee Responsibility'' section in the final standard that would state that if employees are not following what they are supposed to do under the rule, their employers will not be cited for violating this standard.

OSHA disagrees with Dow's views in the matter of employee responsibilities. It is the employer, not the employee, who controls the conditions of work. If an employee, as Dow's comment suggests, is not observing appropriate work practices, it is the employer's responsibility to compel compliance. Employers must manage the conditions in their workplace; they must lead by example, train their employees in the use of controls and safe work practices, reinforce such practices, and, if necessary, establish a disciplinary system so that employees understand that they must follow safe and healthful practices on the job. However, OSHA does not believe that employers must be the ''insurers'' of their employees' behavior. If, for example, an employer establishes, implements, trains employees in, and enforces safe work practices, and does so in a consistent manner, the employer will not be liable for an employee's unforeseeable violation of its safety rules.

In contrast to those commenters who found the proposed provisions vague, some commenters found the proposed evaluation requirements too specific. For example, the Eastman Kodak Company (Ex. 30–429) argued that only the proposed basic obligation should be included in the final rule and that the specific requirements should be deleted: ''We believe . . . [these requirements address] general management practices that should not be mandated but should be provided in a non-mandatory appendix.''

OSHA believes that the final rule's provisions provide employers with the steps to follow to conduct an effective and efficient program evaluation. Absent such provisions, many employers, particularly smaller ones, would not know how to conduct an evaluation. Accordingly, the final rule includes paragraphs (u)(1) and (2), which mandate certain evaluation steps and procedures and establish the minimal frequencies of periodic program evaluations. Many employers, however, such as Kodak, who have had ergonomics programs for years, are unlikely to need such direction.

The Labor Policy Association, Inc. (LPA) (Ex. 30–494), the Department of Defense (Tr. 9085–9086) and (Ex. 30–3781) cautioned OSHA about the difficulties that could arise from doing a program evaluation shortly after creating a new ergonomics program. Specifically, the LPA argued that ''newly implemented ergonomics programs typically experience a spike in reported MSDs that at some point levels off and begins to drop. However, it can take as long as four years before the drop starts to occur. Under the standard, an employer whose reported MSDs were increasing would be required to implement different mechanisms to correct the program's deficiencies. However, an OSHA compliance officer could view this as evidence of an ineffective ergonomics program and launch an in-depth compliance review, even though the increase in MSDs is a natural outcome of having a new but effective program.'' Similarly, the DOD argued that time must be allowed to elapse for ergonomics programs to gather data needed for evaluations.

OSHA is fully aware that the number of MSDs reported may increase, and often substantially, in the first year or so after program implementation. The Agency believes that the examples of effectiveness measures OSHA includes in final paragraph (u)(1)(iv) are sufficiently varied to be suitable for workplaces with programs at various stages of maturity.

Finally, the UFCW (Ex. 32–210–2) asked OSHA to require employers to respond to and, if warranted, address issues raised by employees during a program evaluation. ''The employer should be required to take action to reduce or eliminate hazards uncovered by an evaluation based upon employee concerns. This type of response and evaluation will only serve to strengthen the entire ergonomics program by building confidence among employees that they are a valuable source of information and also can be part of the evaluation process.'' OSHA believes that employers will respond to employee concerns during evaluations when they seek inputs from them about the effectiveness of the program. To do otherwise would be inefficient as well as non-responsive. This does not mean, of course, that employers must respond to all employee suggestions, as some commenters feared (see, *e.g.,* Exs. 30–

3284, 30–3853, 30–710). Because OSHA believes that such two-way communication will be encouraged by the final rule's evaluation provisions, the Agency has decided not to mandate such responses in the final rule's program evaluation provisions.

Paragraph (v)—What Is My Recordkeeping Obligation?

The final recordkeeping provisions specify that employers (except those with fewer than 11 employees) must keep those records essential to any effective ergonomics program. OSHA observed in the proposal (64 FR 65861) and continues to be convinced that occupational injury and illness records are a vital part of an effective ergonomics program in all but the very smallest establishments. Records provide employers, employees, and consultants with valuable information on conditions in the workplace and can be used to identify trends over time and to pinpoint problems. However, OSHA also continues to recognize the need to reduce paperwork burdens for all employers, especially small employers, to the extent that this can be done without reducing safety and health protections. OSHA proposed to limit both the kinds of records employers were required to keep and the applicability of the standard's recordkeeping requirements to very small employers. With very few changes, the final rule contains the recordkeeping requirements that were proposed. OSHA believes that the approach to recordkeeping in the final rule is consistent with the Paperwork Reduction Act's emphasis on minimizing paperwork burdens for small employers whenever possible.

Because larger employers have more complex workplace organizations, OSHA proposed that larger employers would be required to keep records of employee reports of MSDs and the employer's responses to them; the results of job hazard analyses; records of Quick Fix controls; records of controls implemented in problem jobs; program evaluations; and records of the MSD management process. OSHA proposed to exempt employers with fewer than 10 employees from the standard's recordkeeping requirements because in these very small workplaces, information can be communicated and retained informally. The final rule requires that employers with ergonomics programs keep the same records as those proposed. However, the final rule expands the recordkeeping size threshold from 10 employees to 11 employees. This expansion will make the recordkeeping size threshold for this rule consistent with that for OSHA's recordkeeping rule (29 CFR Part 1904).

The following paragraphs discuss the specific requirements of the recordkeeping provisions of the final ergonomics rule and the comments OSHA received in response to the proposed recordkeeping requirements. OSHA has carefully evaluated participants' comments concerning the records needed for effective ergonomics programs to assure that the final standard only requires employers to keep those records that are necessary, *i.e.,* those records that have utility to employers, employees, and OSHA.

Paragraph (v) of the final rule, entitled ''What is my recordkeeping obligation?'' establishes which employers must meet the rule's requirements for recordkeeping. This provision requires employers with more than 10 employees at any time during the previous calendar year to keep records of their ergonomics program. Employees to be counted toward this total include part-time and seasonal employees and employees provided through personnel services. Under the proposed rule, employers with fewer than 10 employees would have been exempt from having to keep any ergonomics program-related records. As noted above, the final rule increases this size threshold to ''more than 10 employees.'' OSHA's experience indicates that, because of the absence of management layers and multi-shift work, informal communication may be used in very small companies, and formal recordkeeping systems may not be necessary. A very small establishment may have a very simple and informal, but nevertheless effective, ergonomics program that does not need written records.

OSHA proposed, and the final rule includes part-time and seasonal employees and employees provided through personnel services when they count the number of employees they employed at any time during the previous year. As explained in the proposed preamble (64 FR 65861), these part-time and temporary employees are retained and supervised by the employer on a daily basis even though this may be the case only for a limited time. As discussed above, establishments with more than 10 employees generally should be required to keep records because they are likely to have more than one layer of management and therefore need to have written procedures. In addition, if these employees were not counted toward the size threshold for recordkeeping, large workplaces that operate with few permanent employees but numerous temporary employees (an organizational structure that is increasingly common) would not be required to keep records despite several levels of management and more formal methods of communication.

The proposed rule's exemption for very small employers elicited several comments. These comments addressed the usefulness of the standard's small business recordkeeping exemption and argued that part time, seasonal, or leased employees should not be included in the count of employees that triggers recordkeeping. In addition, the Department of Navy commented on the future applicability of the standard to federal facilities.

Usefulness of the small business recordkeeping exemption. Some rulemaking participants (see, *e.g.*, Exs. 30–2493, 3596; Tr. 2982–83, Tr. 8394, Tr. 15522, Tr. 15565) argued that the proposed small business exemption would not be useful to small businesses because small employers would choose to keep records anyway. For example, the National Federation of Independent Business (Ex. 30–3596, pp. 4–5) stated that

> OSHA has touted its paperwork exemption and ''quick fix'' alternatives to the full ergonomics program requirements as provisions in the ergonomics standard that were revised to appease small business concerns. Although a ''paperwork exemption'' may appear to help on its face, a small-business owner would be ill-advised not to write down and keep records of everything related to their ergonomics program when faced with the constant possibility of an OSHA inspection.

This comment echoes statements made by the small entity representatives who participated in the Small Business Regulatory Enforcement Fairness Act (SBREFA) panel for this rule. These representatives maintained that they would choose to keep records even if they were not required by the standard to do so (Ex. 23). In response to these small business commenters, OSHA notes that employers are always free to keep any records that they wish to maintain, but the final rule does not require them to do so.

Part-time workers should not count toward the total. Some rulemaking participants (see, *e.g.,* Tr. 3324, Tr. 5638–39) indicated that the provision describing which employers must keep records needed to be clarified and simplified to state explicitly that seasonal, leased, and part-time employees should be included in the total count. Other commenters (see, *e.g.,* Exs. 30–240, 429, 1090) felt that the inclusion of temporary, seasonal, and part-time employees in the count of employees was burdensome or unnecessary. For example, The Eastman Kodak Company (Ex. 30–429, p. 8) remarked that

> This creates significant difficulties in that the prior health histories of such workers are unknown to the contracting employers and initial health checks are usually not conducted. Personnel service workers could have pre-existing conditions that could become aggravated without MSD factors being present in their workplaces.

OSHA's rationale for including these employees is that it is the number of employees, not the duration or kind of employment relationship they have with the employer, that necessitates the keeping of records. The size of the workforce is the factor that makes layers of management and more formal methods of communication (and therefore recordkeeping) necessary. In fact, supervising part-time or leased employees often adds considerable complexity to management planning, oversight, and recordkeeping. Thus, the final rule uses a workforce of more than10 employees on any day of the previous calendar year as the size threshold that triggers compliance with the rule's recordkeeping requirements.

Applicability to federal facilities. In a comment unique to federal agencies, the U. S. Department of Navy (Ex. 30–3818, p. 2) recommended that OSHA ''acknowledge the different recordkeeping requirements for federal agencies and rewrite * * * [the standard] to include provisions for the federal facilities recordkeeping program of 29 CFR 1960.'' OSHA has considered this request, but has decided that a separate provision stating the applicability of the rule to federal facility recordkeeping programs is unnecessary because this matter is better addressed in a compliance directive for affected federal agencies.

Paragraph (v) of the final rule, which corresponds to section 1910.940 of the proposed rule, establishes the final rule's requirements for keeping the records required by the standard. It specifies which records employers must keep and how long they must keep them. OSHA proposed that employers required by the standard to keep records maintain the following:

- Employee reports of MSDs and the employer's responses to these reports,
- II The results of job hazard analyses and Quick Fixes,
- II The controls implemented to reduce or eliminate MSD hazards,
- II The MSD management process, and
- II The results of ergonomics program evaluations.

OSHA also proposed that most ergonomic program records be retained by the employer for 3 years or until replaced by an updated record, and the final rule mandates the same retention periods. The final rule, like the proposal, makes an exception to the 3-year retention period for MSD management records. These records are required to be maintained for the length of the injured employee's employment plus 3 years, a retention period considerably shorter than that required for other OSHA-mandated medical records. OSHA health standards, for example, generally require exposure records to be kept for 30 years and medical surveillance records to be kept for the duration of employment plus 30 years, as required by 29 CFR 1910.1020, OSHA's access to employee exposure and medical records standard. These lengthy retention periods are appropriate for many toxic substances and harmful physical agent standards because of the long latency between exposure on the job and the onset of disease. However, since the latency period for most musculoskeletal disorders is shorter than is the case for many of the chronic conditions and illnesses covered by other OSHA rules, the Agency believes that a shorter retention period is appropriate for the ergonomics rule. Also, changes in the workplace, such as equipment or process changes, often make older ergonomics records irrelevant to current jobs and the present workplace environment. Employers' ergonomics programs continue to evolve, with records of the most recent aspects of that evolution being the most relevant for employee protection.

The proposed recordkeeping provisions elicited several comments. Commenters addressed the following issues: the potential burden imposed by the recordkeeping requirements; the kinds of records employers should keep; the appropriate retention period for program-related records; the need to permit employees and designated representatives to access the records; and electronic recordkeeping. The paragraphs below discuss the comments; OSHA's responses to the comments follow this discussion.

Several rulemaking participants agreed with OSHA's proposed recordkeeping requirements (see, *e.g.*, Exs. 32–339–1, 182–1; Ex. 500–206; Tr. 3488). Typical of the views of these commenters was the comment of the AFL–CIO (Tr. 3488) ''The recordkeeping provisions of the rule * * * are necessary for the effective implementation of the program.''

Recordkeeping requirements are burdensome. A number of rulemaking participants (see, *e.g.*, Exs. 30–74, 294, 429, 526, 544, 546, 652, 653, 710, 1070, 1090, 2428, 2433, 2807, 2991, 3284, 3336, 3367, 3557, 3593, 3723, 3745, 3765, 3770, 3781, 4134, 4184, 4185, 4628, 4839; Exs. 32–77–2, 300–1; Exs. 500–7, 16, 113, 130, 145, 163; Tr. 3136–37, Tr. 5039, Tr. 5334–35, Tr. 5493, Tr. 5638, Tr. 9207–9209, Tr. 12198–99, Tr. 12770, Tr. 12860, Tr. 16486–87, Tr. 16491, Ex. 500–163) argued that the proposed recordkeeping requirements were excessive, burdensome and unnecessary. For example, a commenter for Owens Corning (Ex. 500–163, p. 7) stated that

> The recordkeeping requirements in the proposed standard are excessive and poorly defined. In addition, the implied documentation requirements of the proposed standard are inconsistent with the requirements of * * * [the proposed rulemaking section], *i.e.*, the real recordkeeping requirements are much more extensive than those specifically required by this section.

OSHA also received numerous pre- and post-hearing form letters to the effect that the proposed recordkeeping section was burdensome or unnecessary (see, *e.g.*, Exs. 30–2252, 2251, 2360, 4226, 4748, 0382, 2973, 2224, 0591, 0422, 1126, 4684, 4794, 2246, 0382, 2747, 3331, 2244, 2337, 2888, 3517, 0176, 2902, 639, 2874, 4624, 3090, 0070, 2794, 5104, 4402, 1073, 2999, 2033, 2097, 2345, 1304, 2908, 4404, 5187, 4718, 2354, 2359, 4269, 4690, 691, 3201, 3400, 2866, 0597, 1806, 0912, 4605, 2343, 2130, 4422, 1931, 2258, 2998, 2827, 0378, 2342, 2939, 2298, 4946, 2787, 3403, 3293, 2938, 2450, 1672, 2995, 4440, 4944, 2317, 4446, 2853, 0569, 2877, 2994, 2953, 2096, 3130, 1603, 2763, 2885, 3451, 1026, 2884, 2924, 4795, 0455, 2336, 0433, 2197, 1540, 2758, 4796, 2972, 2858, 3294, 4416, 2971, 4798, 4432, 1085, 4657, 2755, 5098, 3982, 5080, 5057, 5053, 2977, 2979, 5009, 3852, 5070, 2978, 3970, 4768, 3983, 4806, 2469, 3971, 3935, 5075, 5078, 2974, 2980, 4802, 2976, 3005, 2975, 2981, 5026, 3798, 2982, 2526, 2285, 3995, 4785; Exs. L30–4958, 4964, 4967, 5211; Exs. 601–X–249, 419, 1298; Exs. 500–1–224, 225, 226, 228, 229, 230, 231, 232, 233, 234, 235, 236, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 249, 250, 251, 252, 253, 254, 255, 256, 257, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 309, 310, 311, 312, 313, 314, 315, 316, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 365, 366, 367, 368, 369, 370, 371, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 398, 399, 400, 401, 402, 403, 405, 406, 407, 408, 409, 410, 411, 412, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 453, 456, 459).

Some proposed records are not required. Some rulemaking participants questioned the need to keep certain of the records OSHA proposed that employers retain (see, *e.g.,* Exs. 32–3004, 30–294, 30–494, 30–2433, 30–1294, 30–3356, 30–4628, 500–177–2). These commenters argued that the OSHA Log, medical records, and program evaluations were all that were needed (Ex. 32–300–1), that Quick Fix records were unnecessary (Exs. 30–294, 30–494, 30–2433), that records of ''preventive'' or ''voluntary'' work restrictions should not have to be kept (Exs. 30–1294, 30–3356, 30–4628, Ex. 500–177–2), and that employee reports of MSDs or their signs and symptoms were not needed (Ex. 30–2433).

The reasons given by these commenters varied. For example, the Edison Electric Institute (Ex. 32–300–1) believes that only a few records are needed for effective programs: ''The current required recordkeeping records including the OSHA 200 Log and medical records along with the program evaluation should be sufficient to maintain a current and effective ergonomics program.'' The Exxon-Mobil Corporation saw no value in keeping records of employee reports of MSDs (Ex. 30–2433, p. 4), stating that

> The [proposed] standard calls for detailed records of job hazard analyses and hazard control tracking which establishments do not normally maintain. For example, if a computer monitor is raised 2 inches by use of a monitor block, that action—and any subsequent adjustment to the height—must be documented and the document retained. Furthermore, most of the records OSHA proposes to be maintained are not necessary for an ergonomics program. OSHA should revisit the recordkeeping requirements and remove the requirements for employee reports and responses, and quick fix controls.

The Dow Chemical Company (Ex. 30–3765) saw no value in keeping records of job hazard analyses for 3 years: ''Job hazard analyses should only be kept while the employer is working through solutions to reduce the risk of the hazard to an acceptable level.''

The appropriate retention period. The proposed 3-year retention period also elicited several comments; commenters suggested periods ranging from 90 days to more than 30 years. Several rulemaking participants (see, *e.g.*, Exs. 30–297, 3913, 4538; Exs. 32–85–3, 339–1, (185–3–1); Tr. 3488) stated that the standard's record retention periods should be set at five years in the final rule, to be consistent with the retention period for the Log of Injuries and Illnesses and related records found at 29 CFR 1904.6. The Dow Company commented that the proposed retention periods were too long, arguing that ''[t]here is no safety or health reason for keeping records beyond their usefulness'' and recommending that job hazard analyses ''should only be kept while the employer is working through solutions to reduce the risk of the hazard to an acceptable level.'' (Ex. 30–3765, p. 116) August Mack Environmental Inc. agreed that the proposed 3-year retention period was appropriate, without providing additional reasons why (Ex. 30–240, p. 367).

Some rulemaking participants (see, *e.g.*, Ex. 30–3686; 31–353) stated that medical records related to employee exposure to ergonomic risk factors should be kept for the duration of employment plus 30 years, as OSHA requires for other records covered by 29 CFR 1910.1020, OSHA's access to employee exposure and medical records standard, while another commenter (Ex. 30–525) stated that *all* of the records required by the standard should be kept according to the requirements of 29 CFR 1910.1020. Another commenter, the National Telecommunications Safety Panel (Ex. 30–3745, p. 16), expressed concern that the proposed recordkeeping requirements could potentially conflict with those of 29 CFR 1910.1020 and might raise employee privacy issues because some of the records could be ''[p]ersonal and individual in nature (*e.g.* job hazard analyses to accommodate individual injury or illness)'' and ''[p]rivacy issues beyond mere compliance with [proposed] 1910.940.''

Many commenters (see, *e.g.*, Exs. 30–2116, 2809, 2825, 2847; 3001, 3033, 3034, 3035, 3258, 3259, 3332, 4159, 4534, 4536, 4546, 4547, 4548, 4549, 4562, 4627, 4776, 4800, 4801) maintained that all records other than MSD management records should be kept for 10 years. Representative of these comments, Gladys Vereesi argued that a 10 year retention period would allow an ergonomics program to improve upon past history, that a 3-year retention period limited the inputs for ergonomics program evaluation and that ''[i]mportant lessons learned will be lost (Ex. 30–2116, p. 9).

Access to the records kept. Many rulemaking participants (see, *e.g.*, Exs. 30–2809, 3001, 2116, 2825, 2847, 3033, 3034, 3035, 3258, 3332, 4159, 4536, 4546, 4547, 4548, 4562, 4627, 4776, 4800; Exs. 32–339–1, 185–3; Ex. 500–218; Tr. 3488) stated that the final rule should explicitly provide for access by employees or their designated representatives to all records required by the standard. Typical of the views of these commenters is the comment of the United Automobile Workers (Ex. 32–185–3–1, p. 7), which stated:

> Other matters discussed in this section * * * are employee reports and responses, and control records. First, it should be clear that these are available to affected employees and their representatives.

Electronic records. The American Trucking Associations, Inc. (Ex. 30–3330) asked OSHA to add the phrase ''in paper, photographic, microfilm, microfiche, CD–ROM, electronic or other appropriate format'' to allow employers to ''[t]ake advantage of less costly records storage alternatives while ensuring retention of the required records * * *''

Responses to comments received. In this section, OSHA specifically responds to the issues raised by commenters on the proposed recordkeeping provisions.

First, some commenters (see, *e.g.*, Exs. 30–297, 30–3913, 32–85–3, 32–339–1, Tr. 3488) argued that the ergonomics standard should not have separate recordkeeping provisions but instead that the Agency's recording and reporting rule (the ''recordkeeping rule'') (29 CFR Part 1904) should govern such requirements. These commenters are confused about the purpose of that rule, which is to record *all* occupational injuries and illnesses that meet the rule's recordability criteria. Part 1904 does not address the records necessary for an effective safety and health program or the records that must be kept by employers to comply with the Agency's substance-specific or hazard-specific rules, such as this ergonomics program rule. It is routine and appropriate for rules addressing specific hazards, such as the confined spaces rule (29 CFR 1910.146), the lockout/tagout rule (29 CFR 1910.147), and many others, to include recordkeeping requirements geared to those hazards. Accordingly, OSHA has not adopted this suggestion.

Many commenters (see, *e.g.*, Ex. 30–2428, Tr. 9207, Ex. 32–21–1–2) argued that the rule's recordkeeping requirements are unnecessarily burdensome. OSHA disagrees. Employers must keep records of their program activities for a variety of reasons: to ensure that the program is working as intended and that resources are not being wasted; to ensure that MSDs are being addressed effectively, that employees are reporting their signs and symptoms as early as possible, and that Quick Fix and other controls are working; and to ensure that MSD management is helping injured employees to recover as soon as possible. OSHA believes that the records required by the final rule are the minimum necessary for an effective program. Simply relying on 200 Logs, medical records, and evaluation records, as the Edison Electric Institute suggested (Ex. 32–300–1) would mean that an employer would not have records of the controls implemented, the kinds of MSD signs and symptoms occurring, or the methods used to conduct job hazard analysis at the establishment. In this respect, OSHA agrees with the views of one commenter (Tr. 7420) who noted that there is often a discrepancy between the data on an establishment's 200 Log and what is happening on the floor: ''When you actually review the first report of injury, you will conclude that the OSHA 200 Log * * * has no report of cumulative trauma and/or repetitive strain injury when in fact musculoskeletal disorders are at epidemic proportions.'' OSHA believes that most employers would agree that all of the records required by the final rule will provide information essential to effective ergonomics programs.

As to the suggestion (see, *e.g.*, Exs. 30–297, 30–3913, 32–185–3–1) that the retention period be 5 years instead of 3 years to coincide with OSHA's retention periods under the recordkeeping rule, OSHA notes that the 3-year retention period specified in the final rule is consistent with the frequency of required program evaluations, where these records will be most useful. However, employers are always free to keep their records for *longer* retention periods if doing so is consistent with or beneficial to their management practices. Also, even where an employer is permitted under paragraph (y) of the final rule to discontinue the ergonomics program for a job, the employer must still keep the records required to be kept under paragraph (v) for the amount of time listed in paragraph (v)(4).

OSHA agrees that employers may keep these records electronically, and paragraph (v)(1) of the final rule makes this clear.

Some commenters (see, *e.g.*, Exs. 30–1294, 30–3356) urged OSHA not to require that records of temporary work removals or work restrictions be kept if such removals or restrictions were ''preventive'' or ''voluntary'' in nature. OSHA is unclear about what the commenters meant by ''voluntary'' or ''preventive'' restrictions. If the restriction is assigned *after* the employee reports signs or symptoms, the employee has experienced an MSD incident, and removal or restriction must be treated in accordance with the requirements in paragraph (v)(1). The restriction or removal of a symptomatic employee is thus simply a temporary work removal or restriction, as those terms are used in the final rule. If, on the other hand, the employer assigns an employee to another job *before* that employee is symptomatic, the reassignment is simply an administrative control, *i.e.,* job rotation. Records of work restrictions or removals are required to be kept by the final rule; records of routine job reassignments or rotations (*i.e.*, those not done as part of the employer's strategy to control or eliminate MSD hazards) are not.

OSHA agrees with those commenters (see, *e.g.*, Exs. 30–2809, 32–339–1, 32–185–3, 500–218) who pointed out that the proposal failed to provide access to records by affected employees and their designated representatives. The final rule, at paragraph (v)(2) and (v)(3), corrects this oversight.

Summary. After a review of the rulemaking record, OSHA has decided in the final rule to retain the proposed 3-year (or until replaced by an updated record) retention periods for most of the required program records. The record, as discussed above, contains a wide range of opinion about the appropriate retention period for these records. OSHA was not convinced to change the required retention periods either by comments in favor of very short retention periods (see, *e.g.*, Ex. 30–3765, which recommends a 90-day comment period) or those arguing for a retention period of 30 years or more (see, *e.g.*, Ex. 30–525).

Records of job hazard analyses, hazard controls implemented, Quick Fix controls put in place, ergonomics program evaluations, and MSD management records must be kept for the employees and jobs covered by the employer's program. Further, as required by paragraph (v)(2), employees or their designated representative(s) must be given access to those records that address their report(s) of MSD incidents and the employer's response(s) to those reports.

Paragraph (w)—When Does This Standard Become Effective?

In paragraph (w) of the final rule, which corresponds to § 1910.941 of the proposal, OSHA establishes the date when the final rule becomes effective. The effective date is the date from which the compliance deadlines in this section are counted.

In the proposal, OSHA stated that the ergonomics standard would become effective 60 days after the publication date of the final rule. OSHA stated that this period would provide sufficient time for employers to review the final rule, get assistance, and prepare to meet the initial requirements of the standard as it applied to them.

The proposed effective date section elicited few comments. Some rulemaking participants (see, *e.g.,* Exs. 30–3686, 32–85–3, Tr. 13132) agreed with the 60-day effective date. Other commenters (see, *e.g.,* Exs. 30–74, 30–3765) felt that 60 days was insufficient. For example, the Dow Chemical Company (Ex. 30–3765, p. 118) urged OSHA to change the effective date to 180 days so that companies with existing programs, like Dow, would have sufficient time to review and make any necessary changes prior to the standard becoming effective.

OSHA understands that employers with existing programs will need time to review their programs, either to establish that they qualify for ''grandfather'' status under paragraph (c) or to modify their programs to match the requirements of the final rule. However, OSHA believes that the 60-day date before the final rule takes effect, together with the additional time allowed for the implementation of the ergonomics program elements, will allow sufficient time for this purpose. Moreover, any further delay would unnecessarily deprive employees of needed protections against MSDs.

George Nagle, the Corporate Senior Director of Environmental Health and Safety for the Bristol-Myers Squibb Company (Ex. 31–302, p. 1, Tr. 10519–10521) suggested that a pilot program of at least one year should be implemented in OSHA's national and regional offices prior to attempting to impose a final ergonomics rule on the regulated community. However, there was insufficient detail in the suggestion to determine how such a program would work, or whether such a pilot program strategy would be beneficial to employees. In addition, there was little or no support in the record for the implementation of such a pilot program. OSHA believes that a significant number of companies have successfully implemented an ergonomics program already; the economic analysis estimates that approximately 20 percent of general industry companies have done so. Although it does not believe a pilot program is necessary, OSHA does intend to provide extensive compliance outreach to industry when the standard is published, and has included useful compliance information in the Appendices to this rule. After reviewing the record on this issue, OSHA has concluded that the 60-day effective date is appropriate and sufficient for employers to read and understand their obligations under this final rule.

Compliance Time Frames

OSHA's approach to compliance deadlines in the proposal differed from that in other OSHA standards. First, OSHA proposed a long start-up period so that employers would have time to get assistance before the compliance deadline. Second, even after the compliance deadlines, OSHA proposed to give employers newly covered by the standard (*e.g.,* employers whose employees develop MSDs after the compliance deadlines have expired) additional time to set up an ergonomics program and implement controls. Third, OSHA proposed to allow employers to discontinue large portions of their ergonomics programs if no MSDs were reported for a specified period of time.

Paragraph (x)—When Must I Comply With the Provisions of the Standard?

In paragraph (x) of the final rule, which corresponds to proposed § 1910.942, OSHA establishes deadlines for compliance with the requirements of the ergonomics standard.

In the proposed rule, OSHA allowed for start-up times for employers to set up the ergonomics program and implement controls in problem jobs. The proposal would have required the employer to implement MSD management promptly when an MSD was reported; to set up management leadership, employee participation, and hazard information and reporting within 1 year of the effective date of the final rule; to implement job hazard analysis, interim controls, and training within 2 years of the effective date of the final rule; and to implement permanent controls and conduct program evaluation within 3 years of the effective date of the final rule. The proposed start-up times thus ranged from 1 to 3 years.

Based on an evaluation of the comments received on the proposed compliance dates, OSHA has revised them in the final rule. The compliance deadlines in the final rule are staggered, as they were in the proposal, although some dates fall earlier and some later than they did in the proposal. Comments received on the proposed dates, and OSHA's response to the comments, are discussed below.

Like the proposal, the final rule recognizes that employers need to begin setting up their ergonomics program soon after the rule is issued so that they will have an effective process in place in time to meet the compliance deadlines. Without phased-in start-up periods, some employers might wait until the last minute to take action. The final rule's phased-in compliance periods are also designed to ensure that employees who report MSD signs and symptoms are provided with prompt intervention (both MSD management and work restrictions) in order to help resolve the problem quickly and without permanent damage to the employee. The phase-in approach taken by the Agency was supported by commenters, such as the AFL–CIO, which stated that ''the overall timeframes for compliance * * * are more than sufficient'' (Tr. 3488).

Finally, the longer start-up periods will also allow employers to integrate needed job modifications into their regular production schedules or processes. The best way to control MSD hazards is often in the design process; allowing additional compliance time allows establishments of all sizes to make needed changes to their processes as part of regular production changes, and perhaps to make those changes at less cost. The final rule allows an initial period of 4 years for employers to implement permanent controls.

The proposal envisioned two levels of ergonomics programs: a basic program for manual handling and manufacturing jobs (which included management leadership, employee involvement, hazard information, and employee reporting of MSD signs and symptoms) and a full program for employers whose employees developed work-related MSDs that were covered by the standard. The full program would have included all of the elements of the basic program plus job hazard analysis, job controls, training, and program evaluation. Employers who had manufacturing or manual handling jobs in their establishments would have had one year from the effective date of the rule to comply with the basic program requirements, and later compliance deadlines for other requirements of the full program (job hazard analysis, job controls, training, and program evaluation, if a covered MSD is reported).

OSHA has simplified the scope of the final rule by eliminating the distinction between manual handling and manufacturing jobs and other jobs. Accordingly, the phased-in compliance deadlines for manual handling and manufacturing jobs found in the proposal do not appear in the final rule (see the summary and explanation for paragraph (b)).

Like the proposal, the final rule does not contain different compliance deadlines for small and large employers. This is the case because OSHA believes that the compliance deadlines allow enough time even for very small employers to obtain information about the rule and ways to implement an ergonomics program. OSHA also believes that the final rule's 4-year phased-in compliance period for controls is adequate for larger employers who might have more complex processes, employees, problem jobs, and controls to implement.

Some rulemaking participants (see, *e.g.,* Exs. 30–3813, 30–3826) stated that the compliance dates in the proposal were logically inconsistent and needed to be rewritten. These commenters found this section on phased-in dates for program requirements to be difficult to follow and confusing.

Some commenters (see, *e.g.,* Exs. 32–339–1, 182–1, Tr. 383–384) noted that under the compliance deadlines set forth in the proposal, some employees with MSDs who had already been removed from their job might be returned to the problem job before the proposal required the employer to implement interim controls. OSHA agrees that this could be the case in some circumstances and has revised the final rule accordingly.

The compliance time frames in the final rule have been modified as follows: paragraph (x)(1) gives the employer 9 months after the standard becomes effective (60 days after promulgation) to provide the information required in paragraph (d) to employees. This includes information about MSDs and their signs and symptoms and how to report MSDs as well as the kinds of risk factors, jobs and work activities associated with MSDs (see preamble discussion for paragraph (d) for a more complete discussion of the information required to be disseminated).

The rest of the compliance time frames are presented in paragraph (x)(2), Table 2. After an employee reports an MSD (or signs or symptoms of an MSD), the employer must determine whether the MSD is work related, whether it requires a work restriction and, where appropriate, whether the employee's job meets the standard's Action Trigger (see the preamble discussions for paragraphs (e) and (f) for further details on these requirements). If an employer determines that an MSD incident has occurred (*i.e.,* a work-related MSD that requires medical treatment beyond first aid or restricted work, or MSD signs or symptoms that last for 7 consecutive days) (see definition of MSD incident), then the employer has 7 days in which to determine whether the employee's job meets the Action Trigger (defined in paragraph (f) of the standard). If the employee's job meets the Action Trigger, then the employer has 7 days in which to initiate MSD management, which includes access to a Health Care Professional (HCP), an evaluation of the employee's condition, any appropriate work restrictions (including WRP for up to 90 days) (see preamble discussion of paragraphs (p), (q), (r), and (s) for further details of the employer's MSD management responsibilities). If the employee's job meets the Action Trigger, the employer has 30 days in which to initiate the management leadership element of the program (assign responsibility for setting up and managing the ergonomics program and communicating with employees about the ergonomics program) and the employee participation element (ensuring that employees have ways to report and receive prompt responses to reported MSDs and have ways in which to be involved in the development and implementation of the ergonomics program) (see preamble discussions for paragraphs (h) and (i) for further details of these requirements).

Within 45 days of determining that a job meets the Action Trigger, the employer must train employees in setting up and managing the ergonomics program (see preamble discussion for paragraph (t) for further details of this requirement). Also, a job hazard analysis of the problem job must be initiated within 60 days of a determination that the job meets the Action Trigger (see preamble discussion of paragraph (j) for further details of this requirement). Within 90 days after a determination that a job meets the Action Trigger, the employer must implement interim controls and initiate training for employees, supervisors and team leaders involved in the ergonomics program (see preamble discussion of paragraphs (t) and (m)(2) for further details on these requirements).

Finally, the employer must implement permanent hazard controls to fix a problem job (so that any MSD hazards presented by the job no longer are likely to cause MSDs that result in work restrictions or medical treatment beyond first aid) within 2 years of a determination that a particular job meets the Action Trigger. The final rule allows the employer up to 4 years (after a determination that a job meets the Action Trigger) for initial implementation of the permanent controls provisions (see preamble discussion of paragraph (m)(3) for further details of this requirement). The final standard has kept the proposed requirement to evaluate the effectiveness of the ergonomics program within 3 years (after a determination that a job meets the Action Trigger) and to promptly correct any deficiencies in the program that the evaluation reveals (see preamble discussion of paragraph (u) for further details of this requirement).

Therefore, the effective date section in the final rule has been modified to avoid the unwanted results some commenters (see, *e.g.,* Exs. 30–3813, 30–3826) pointed out might have occurred under the proposal's compliance dates. For example, these commenters noted that, an employee with a work-related MSD could, under the proposal, be returned to a problem job before the employer was required to implement interim controls for that job. In the final rule, the employer has a longer period than in the proposal—up to 9 months from the effective date of the rule—to disseminate information to employees about MSDs. After that date the employer must respond promptly to any reported MSDs by taking steps to determine if the employee has suffered an MSD incident (a determination that the MSD is work-related, is persistent, and requires medical treatment beyond first aid, days away from work or restricted work). Once it is determined that an MSD incident has occurred, the employer has 7 days to determine if the employee's job meets the Action Trigger. If the job meets the Action Trigger, all of the other requirements of the standard spring from the date of the Action Trigger determination, and interim controls would need to be implemented within 90 days of this determination. Therefore under the final rule, an employee on work restriction or WRP would not have to face the possibility of returning to an ''unfixed'' job because the WRP period has expired before the employer has a duty to implement at least interim controls.

Some rulemaking participants (see, *e.g.,* Ex. 32–339–1, Tr. 3488–3489) observed that the compliance deadline for management leadership and employee participation in the proposal fell due before the deadline for training. Commenters (see, *e.g.,* Ex. 500–218) were concerned that this phase-in discrepancy would mean that employees would not be able to fully participate in the ergonomics program because they had not had training. Although the proposal would not have *prevented* employers from training employees prior to the 2-year deadline articulated in the proposal, OSHA has modified the deadlines for the training requirements in the final rule to address this concern. The final rule separates the employer's training obligations into segments (with the awareness training required by paragraph (d) given earlier than the training triggered by the Action Trigger). As noted, the final rule includes some employee awareness training for all general industry employees; the requirement to provide this training is the first requirement of the standard to go into effect after the effective date. In addition, paragraph (h), management leadership, and paragraph (i), employee participation, have training components (*e.g.,* information on MSDs, information on the ergonomics program and the requirement to provide responsible persons with the information and resources necessary to meet their responsibility under the program).

Some rulemaking participants (see, *e.g.,* Exs. 30–3813, 30–3826) complained that the terms ''permanent'' and ''interim'' controls used in the effective date section were undefined. Definitions of ''interim'' and ''permanent'' controls have been included in the final rule to further clarify the compliance obligations set forth in the effective date section (see paragraphs (k)(1)(i) and (m)(2)).

A number of commenters (see, *e.g.,* Exs. 30–3745, 30–3913, Tr. 7745–7746, Tr. 16471) felt that the time periods for compliance given in the proposal were inadequate. For example, the National Telecommunications Safety Panel (Ex. 30–3745, pp. 16–17) stated:

> Based on previous discussions of individual program elements within the proposed rule, the Panel believes it would be necessary for employers with more than 10 worksites and 2500 employees across those multiple worksites to have two years after a rule becomes effective to implement ''management leadership'' and ''hazard information and reporting'' as defined in the rule, three years to implement ''job hazard analysis,'' ''interim controls,'' and training, and four years for ''permanent controls'' and ''program evaluation.'' This reflects the distinct probability that most telecommunications companies will maintain a corporate ergonomics program to ensure consistency of compliance, adequate communications and sharing of ''best practices'' across all of their workplaces.

The National Council of Agricultural Employers (Ex. 30–3781) indicated that small employers needed a longer phase-in period, which would allow them to take advantage of innovations undertaken by larger companies. However, this commenter neither stated what length of time would be appropriate for small employers nor whether more time was needed to comply with all of the provisions of the standard or just the interim and permanent control provisions. OSHA also notes that agricultural employment is not covered by this rule (see the summary and explanation for paragraph (b)). OSHA concludes that the times given to comply with the program elements in the final rule are adequate for all employers, including small employers, who will be able to avail themselves of all of the compliance assistance materials OSHA is disseminating, the OSHA consultation program, and other ergonomic resources available.

A number of other comments were received in response to the compliance date section of the proposal. One rulemaking participant (Ex. 30–3913) argued that training should be phased-in over 5 years rather than the proposed 3 years because at present commercially available ergonomic training materials are of inadequate quality and more time would be needed to improve the overall quality of such training materials. OSHA concludes that a wealth of material is already available that can assist in meeting the training obligations in the final rule. (See Docket 777, *e.g.,* ''Ergonomics Awareness Manual (Ex. 32–185–3–11);'' ''Trainer's Manual Ergonomics Program (32–111–1–21).'') In addition even more training materials will become available through OSHA outreach as well as the market for such materials which the promulgation of this rule will create. Further, the training obligations in the final rule are implemented over time, and the materials for them can thus be developed and implemented piecemeal as program development occurs within the workplace.

Some participants (see, *e.g.,* Exs. 30–3922, 30–3032, 30–3284, 30–3922, 32–133–1, 32–300–1, L30–5088, 601–x–1711) thought that the deadlines for interim or permanent controls were too short. Others (see, *e.g.,* Exs. 30–526, 30–710, 30–2433) felt that any deadline for implementing permanent controls was unrealistic, due to the difficulty of providing permanent controls. For example, Pinnacle West Capital Corporation (Ex. 30–3032, p. 12) stated:

> * * * due to the heavy regulation of the plant modification process by the Nuclear Regulatory Commission in electric utility nuclear plants, it is entirely possible that some engineering control implementation could take more than the [proposed] three year permanent control deadline. This is particularly true if the modification can only be accomplished during plant outage times.

This commenter did not indicate how often such plants are off line; however, OSHA notes that the inability of an employer to comply for reasons of infeasibility can always be raised in the context of enforcement. The fact that an employer may confront a highly unusual situation, such as the one this commenter describes, is no reason for the implementation dates for *all* employers to be extended. Another participant stated that the brick-making industry would have problems meeting the proposed three-year phase-in period for permanent controls (Tr. 7745–7746) because they believe that the only permanent controls for their ergonomics problems is automation. OSHA notes that this commenter reported making substantial progress in reducing its MSD hazards, but recognizes that feasibility may be an issue for some establishments.

The American Industrial Hygiene Association (AIHA) (Tr. 16471) noted difficulties that might be encountered in meeting the proposed compliance deadlines for the implementation of interim or permanent controls by stating that ''[i]n some cases, substantial reductions in hazards may require reworking an entire material handling system for even a production line. These types of changes usually require a stage process that may run over three years.'' Again OSHA understands that controls can take some time to implement in certain complex cases, and further that many companies prioritize their jobs for control. OSHA's compliance staff is trained to address these issues on a case-by-case basis, and will do so in enforcing this standard as well.

OSHA has determined that, except in rare cases, employers will be able to meet the compliance deadlines in the final rule. These deadlines are based on a review of the record on the appropriateness of the proposed time given to implement permanent controls. As a result of that review, OSHA has increased the amount of time employers are allowed to implement permanent controls initially to 4 years after the final rule goes into effect, and to 2 years thereafter. This means that the 4-year period is the maximum time that any employer can take to implement permanent controls. In other words, the employer has 4 years after the effective date to install permanent controls or 2 years after the employer determines that a job meets the Action Trigger, whichever is later. For example, if an employer determines that a job meets the Action Trigger 1 year after the effective date, that employer will then have 3 years to install permanent controls. On the other hand, if the employer makes the Action Trigger determination 3 years after the effective date (or 4 years or 5 years after), that employer has 2 years from that date to install permanent controls. This two-tiered approach to the requirement to implement permanent controls initially was adopted to allow employers sufficient time to deal with a possible increase in the number of MSD incidents soon after the standard becomes effective. The Agency believes, once the standard has been in effect for several years, there will be fewer MSD incidents, and that a shorter compliance deadline for permanent controls—2 years—will give these employers sufficient time to implement permanent controls for problem jobs.

The few employers who may find the generous compliance times given in the final rule inadequate also may avail themselves of the temporary variance procedures provided in the Occupational Safety and Health Act of 1970.

Many commenters felt that the compliance deadlines were too long (see, *e.g.,* Exs. 30–2039, 30–2116, 30–2825, 30–2847, 30–3001, 30–3033, 30–3034, 30–3035, 30–3258, 30–3259, 30–30–3332, 30–3686, 30–4159, 30–4534, 30–4536, 30–4546, 30–4547, 30–4548, 30–4549, 30–4562, 30–4627, 30–4776, 30–4800, 30–4801, 31–242, 31–353, 32–85–3, Tr. 11196, 13133).

Typical of comments stating that the deadlines were too long was that of the American Nurses Association (ANA) (Ex. 30–3686, p. 22), which criticized the deadlines on the grounds that they were so long that they would continue to permit opportunities for thousands of nurses and HCWs (health care workers) to be injured. Although the immediate implementation of effective controls on jobs with MSD hazards would be ideal, OSHA recognizes that employers will need time to find, implement, and analyze the effectiveness of controls for each job. OSHA has modified the compliance time frames to address comments such as the ANA's by significantly shortening the amount of time allowed in the final rule for employers to address jobs that meet the Action Trigger. In the final rule, for example, interim controls must be implemented within 90 days of a determination that a job meets the Action Trigger, as opposed to the 2 years given in the proposal. Further, the deadlines in the final rule represent the maximum amount of time employers will have to comply with the elements of the ergonomics program. Employers are encouraged to implement effective controls as soon as possible, and OSHA believes that many employers will do so, because this approach will benefit both employers and employees by reducing the number and gravity of MSD injuries.

Other commenters supported the proposed time frames. For example, the AFL–CIO (Tr. 3488) stated ''[t]he overall time frames for compliance we think are more than sufficient, particularly given that the standard has been under development for so long.'' OSHA understands that the compliance deadlines given are generous, but has concluded that some companies will need the extra time to work needed job modifications into their regular production change schedules. From a review of the comments on this section, OSHA has determined that the final rule strikes a rational balance between the need to respond with due speed to MSD incidents and the benefits of developing remedies to problem jobs in an orderly fashion. Substantial evidence in the record supports the compliance time frames adopted in the final rule.

The Communications Workers of America (CWA) (Tr. 13133) supported the requirement for prompt responses to reported MSDs, but felt that the remaining requirements (management leadership and employee participation, hazard information and reporting, job hazard analysis, training, interim and permanent controls, and program evaluation) should all begin one year after the effective date of the standard. The CWA (Tr. 13133) also stated that hazard information training should be conducted within 30 days after the identification of a problem job. In the final rule, this initial training is required before the identification of a problem job. The CWA also suggested that comprehensive training on MSD hazards, controls, and the employer's ergonomics program should be required 90 days after the identification of a problem job. As noted above, in the final rule, all of the training requirements go into effect within 90 days of a determination that a job meets the Action Trigger. Several training requirements, such as the dissemination of MSD awareness information to employees (paragraph (d)) and the training of employees involved in setting up the ergonomics program (paragraph (t)) have to be met substantially sooner.

Some commenters agreed that MSD management should be provided immediately, or as soon as possible (see, *e.g.,* Exs. 30–2387, 30–4538, 31–105, 31–106, 31–129, 31–170, 31–229, 31–276, 31–309, Tr. 13133). Other participants (see, *e.g.,* Exs. 30–74, 30–2987) felt that the requirement for prompt response, *i.e.,* as soon as an MSD is reported after the effective date, could be disruptive and would result in an employer having insufficient time to prepare for the implementation of the overall ergonomic program requirements. The American Health Care Association (AHCA) (Ex. 30–2987) recommended at least a 1-year delayed effective date for MSD management. The AHCA stated ''[b]ecause we anticipate that MSDs will be reported early under this proposed standard, we envision that the MSD management component deadline will occur almost immediately after the 60-day start-up. This hardly provides an opportunity for employers to receive assistance on MSD management * * * '' In the final rule, the dates in the proposal have been modified to clarify that, although the employer has 11 months from the time the standard is published to disseminate information about MSDs (including their signs and symptoms and how to report them), the employer need not respond to the employee reports initially until the 11-month period has passed. This initial delay in employer response obligations is necessary to permit the employer to develop an ergonomic program in an orderly fashion.

Some commenters felt that after the standard became effective employers should be given 5 days to respond to MSD reports (see, *e.g.,* Exs. 30–400, 30–4837, 31–3, 31–12, 31–113, 31–31–150, 31–160, 31–186, 31–187, 31–192, 31–200, 31–205, 31–243, 31–307, 31–347); others thought that 2 days would be appropriate (Ex. 31–23). These commenters only provided their opinions in this matter, without detail. Other periods of time were also recommended for MSD management deadlines, such as 1 month (Exs. 31–125, 31–265), again without detailed explanation. The proposal (§ 1910.942) had merely required that the employer provide a ''prompt'' response. This requirement has remained essentially the same in the final rule but has been included in paragraph (e) rather than in the effective date section (see preamble discussion of paragraph (e) for a more detailed discussion of the MSD response requirements).

Some commenters (see, *e.g.,* Exs. 31–27, 31–78, 31–170, 31–180) argued that medical treatment deadlines for MSDs are addressed in state workers' compensation laws and that OSHA should not interfere with those requirements. These commenters misunderstand the rule's MSD management provisions. The OSHA rule does not require employers to obtain medical treatment for employees with MSDs; OSHA assumes that MSDs will continue to be treated under the workers' compensation system, as they have been. The MSD management required by the standard requires the employer to provide access to an HCP, if the employee wishes access, solely for the purposes of evaluation and follow-up and, if necessary, work restrictions. The MSD management system required by the standard does not in any way interfere with workers' compensation (see preamble discussion of paragraph (q)). OSHA included the MSD management provisions pursuant to its statutory authority under the OSH Act (see preamble discussion of paragraph (r)). After reviewing a wide variety of opinions as to how long injured employees should wait before receiving MSD management, OSHA has concluded that MSD management should begin within 7 days after a determination can be made that an MSD incident, as defined by this standard, has occurred. Compliance dates are necessary to effectuate the MSD management provisions included in the standard, and OSHA believes that the time frames included in the final rule for MSD management are appropriate and supported by the record.

In § 1910.943, OSHA proposed to establish different compliance time frames for those employers who had not identified a problem job until after some or all of the start-up compliance deadlines established in proposed § 1910.942 had passed. This was because the occurrence of an MSD incident is difficult to predict and may not occur, in some establishments, for many years, *i.e.,* long after the standard's initial start-up dates have run.

In proposed § 1910.943, if an employer incurred a compliance obligation after the compliance start-up deadline for that obligation had passed, a different timetable applied. OSHA's reasons for this timetable, which was shorter than the initial compliance timetable, was that employers in later years would not need as long to implement ergonomics programs because they could take advantage of program development and remedies that had been developed by other employers in the interim. Accordingly, proposed § 1910.943 gave employers with later incurred compliance obligations some additional time to comply, but the time frame between the MSD incident and the remedy was shorter than that proposed for initial compliance when the standard became effective (see 64 FR at 66074).

From a review of the rulemaking record, it is clear that many participants did not understand proposed § 1910.943 or how it would work (see, *e.g.,* Exs. 30–2116, 30–2809, 30–2825, 30–2847, 30–

3001, 30–3033, 30–3034, 30–3035, 30–3258, 30–3259, 30–3332, 30–3826, 30–4159, 30–4534, 30–4536, 30–4546, 30–4547, 30–4548, 30–4549, 30–4562, 30–4627, 30–4776, 30–4800, 30–4801, Tr. 3236). Additionally, this section of the proposed rule elicited a number of comments, most of which were critical (see, *e.g.,* Exs. 32–85–3, 30–297, 30–424, 30–434, 30–1090, 30–2433, 30–3120, 30–3171, 30–4537, 32–85–3, 500–145). However, few commenters provided detailed reasons for their views.

A few commenters (see, *e.g.,* Exs. 30–4538, 30–3686, 31–353, 32–300–1) recommended that proposed § 1910.943's requirement that MSDs be responded to within 5 days be modified to require MSD management ''promptly'' when an MSD is reported. The American Federation of Government Employees (Ex. 30–4538, p. 8) stated:

> OSHA should require medical management sooner than five days. If an employee experiencing MSD symptoms continues to work in the same job without medical attention, his condition could get worse. In general, by the time an employee reports a problem, she has been experiencing symptoms for some time and should not have to wait another few days for treatment.

Some rulemaking participants (see, *e.g.,* Exs. 30–240, 30–526, 30–710, 30–3813, 30–3826, 30–3284, 32–300–1, 501–6) disagreed with the idea of providing less time for later-year compliance in § 1910.943 than was proposed for initial compliance in § 1910.942. For example, the Department of Defense (Ex. 30–3826, p. 11) stated ''[i]t is not clear why two timetables are provided. It seems capricious to allow some employers up to three years to fully implement their ergonomics programs, while others will have only one year.''

Another rulemaking participant (Ex. 32–229–1) observed that the proposed deadline for training expires after the deadline for management leadership and employee participation, which would mean that employees would not be trained before they are expected to participate. In response, OSHA has shortened the deadline for training for employees who are involved in setting up and managing the ergonomics program in the final rule from the proposed 90 days to 45 days after the employer has determined that a job meets the Action Trigger. Employee participation has a deadline of 30 days after the employer has determined that the job meets the Action Trigger.

As noted earlier, in the final rule, the events that trigger an employer's obligations under this standard have been modified since the proposal. All employers covered by the ergonomics standard must comply with the minimal requirements in paragraph (d) (informing employees) within 11 months of the publication of the rule. The remainder of the rule's obligations and time frames for complying with the various requirements are incurred after a determination that an MSD incident has occurred in a job that meets the Action Trigger set forth in paragraph (f). In view of this altered approach in the final rule, it is no longer necessary to provide two separate compliance time frames as was done in the proposal.

Paragraph (y)—When May I Discontinue my Ergonomics Program for a Job?

Paragraph (y) allows employers to discontinue most elements of their ergonomics program for a job if the risk factors in that job have been reduced to levels below those in the Basic Screening Tool (Table 1 of the standard). The only obligations the employer continues to have for jobs that have been controlled to that level are to maintain the controls that reduce the risk factors, continue to provide the training related to those controls, and keep records of the job hazard analysis and the controls implemented for that job.

OSHA proposed to allow employers to discontinue portions of their ergonomics program when no covered MSD had been reported in a problem job for 3 years after the problem job was controlled. Paragraph (y) of the final rule has the same advantages as the proposed provision, but has been revised to reflect changes made to the design of the final rule. That is, the approach taken in the final rule recognizes the role of the Basic Screening Tool in Table 1, which acts, along with the report of an MSD incident, as a trigger for action under the standard and, in paragraph (y), as the mechanism for relieving employers of most of their obligations under the standard.

Some rulemaking participants (see, *e.g.,* Exs. 30–526, 30–710, 30–3686, 31–242) argued that the 3-year timetable for discontinuing elements of the program should be eliminated. These commenters felt that employers with ergonomics programs should be required to maintain all elements of their ergonomics program indefinitely.

Commenters took issue with the proposed timetable for discontinuing parts of the program; some thought the time period was too short, while others argued that it was too long. For example, one rulemaking participant (Ex. 32–185–3) stated that 3 years is too soon to discontinue parts of the ergonomics program, because it gives insufficient time for employers to accurately determine if the controls implemented have been effective. However, this commenter did not suggest what amount of time would be appropriate to wait before discontinuing parts of the program.

On the other hand, some rulemaking participants (see, *e.g.,* Exs. 30–3471, 30–4185, 30–3868, Tr. 3325–3326) thought that 3 years was too long to wait before discontinuing certain aspects of the program. For example, Tyson's Foods (Ex. 30–4185, p. 26) stated ''* * * OSHA has set an unrealistically * * * low threshold * * * by premising the obligation to implement engineering controls on the existence of * * * a single reported MSD and then further requiring employers to continue to search for and implement engineering controls until there are no more MSDs for at least three years * * *''

Other commenters (see, *e.g.,* Exs. 30–3344, 30–3749, 30–4674, Tr. 3325–3326, Ex. 601–x–1710) recommended using alternative criteria for discontinuing elements of the program. For example, Abbott Laboratories (Tr. 3325–3326) stated ''clearly the bar for ending the full program is too high. We propose that OSHA substitute a performance-based replacement for the 'one MSD in three years' criterion.'' OSHA has considered this suggestion but has determined that such a performance-based approach, such as the use of industry averages, would be too complex to apply and too difficult to verify during enforcement.

Some commenters (see, *e.g.,* Exs. 30–2116, 30–2825, 30–2847, 30–3001, 30–3035, 30–3258, 30–3259, 30–4159, 30–4534, 30–4536, 30–4546, 30–4547, 30–4548, 30–4549, 30–4562, 30–4627, 30–4801, 32–85–3, Tr.13134) stated that the proposed rule would permit employers to discontinue too many elements of the ergonomics program. The Communications Workers of America (Tr.13134), for example, stated that management leadership and employee participation, hazard information and reporting, awareness training, program evaluation, and maintenance of controls and the training related to those controls should be continued to ensure the control or prevention of MSDs.

OSHA has considered the possibility of increasing the number of program elements employers are allowed to discontinue if they have reduced the MSD hazards in jobs covered by the standard to levels below those in the screen (Basic Screening Tool in Table 1). However, the Agency has decided that maintaining the controls that allowed the employer to control the job, continuing the training in the use of those controls for employees in these jobs and keeping records of the job hazard analysis and controls for that job are the minimum requirements needed to ensure employee protection. These are the only program requirements the employer is required to continue once the risk factors in the job have been reduced to levels below the screen.

Paragraph (y) contains no time period and no link to the occurrence of MSD incidents, as the proposal did. Instead, both the ''entrance'' to and ''exit'' from most program obligations is tied to the extent of the risk factors in the job, as indicated by the screen.

Paragraph (z)—Definitions

Paragraph (z) of the final rule contains a number of definitions of terms used in this final rule. Most of the definitions are straightforward and self-explanatory. A general discussion of each of the terms can be found below; however, clarification of many of the terms is provided in the summary and explanation sections for the provisions where the terms are used. OSHA believes that describing terms where they are used makes it easier for employers and employees to understand what OSHA means when it uses them.

The following terms are defined in the final rule: ''administrative controls,'' ''Assistant Secretary,'' ''control MSD hazards,'' ''Director,'' ''employee representative,'' ''engineering controls,'' ''follow-up,'' ''health care professionals (HCPs),'' ''job,'' ''musculoskeletal disorder (MSD),'' ''MSD hazard,'' ''MSD incident,'' ''MSD signs,'' ''MSD symptoms,'' ''personal protective equipment,'' ''problem job,'' ''risk factor,'' ''work related,'' ''work practices,'' ''work restriction protection (WRP),'' ''work restrictions,'' and ''you.''

Several terms were defined in the proposal (64 FR 65864 and 64 FR 66075) but are not defined in the final rule: ''covered MSD,'' ''eliminate MSD hazards,'' ''ergonomics,'' ''ergonomic design,'' ''ergonomic risk factors,'' ''have knowledge,'' ''manual handling jobs,'' ''manufacturing jobs,'' ''materially reduce MSD hazards,'' ''MSD management,'' ''no cost to employees,'' ''OSHA recordable MSD,'' ''periodically,'' ''persistent MSD symptoms,'' ''physical work activities,'' and ''resources.'' These terms are either not being used in the final rule, have been replaced by other terms that are defined (either in this paragraph or where they first appear), or have such clear meanings that further definition is unnecessary.

General Comments on Definitions

OSHA received many comments on the definitions for terms used in the proposed ergonomics program standard. A great deal of comment focused on the perceived vagueness of the terms and definitions, with commenters raising concerns about their inability to understand these terms and, thus, their ability to comply appropriately. Others raised concerns about the cost of compliance, arguing that they would spend large sums of money trying to comply because they were unsure what the rule meant (see, *e.g.,* Exs. 32–207–1, 32–206–1, 30–3765, 30–3845, 30–3813, 32–368–1, and 30–3853). One commenter, Monsanto Corporation (Ex. 30–434), recommended moving the definitions to the front of the document for clarity. OSHA has not adopted this recommended change, although a Note to paragraph (a) of the rule states that the definitions for the standard appear in paragraph (z).

OSHA has arranged its discussion of the comments on definitions so that the ''general'' comments—those that apply to all definitions—are discussed first, and the more specific comments—those that pertain to a particular term or definition—are discussed afterward. Additional discussion of some terms can be found in the summary and explanation of the provision where the term is used.

On the overall issue of the vagueness of the definitions, commenters said that terms were unclear or too broadly defined, which would make it difficult for them to implement the standard (see, *e.g.,* Exs. 30–294, 30–434, 30–1897, 30–3765, 30–2208–2, 30–3845, 30–1722, 30–3813, 30–4185, 30–3739, 30–4006, 30–2705, 30–4038, 601–X–1379, 30–3889, 30–2540, 30–4760, 30–4021, 33–1455, 30–4599, 33–1463, 33–1462, 30–2751, 30–4982, 30–5009, 30–2598, 30–2569, 30–4149, 30–4963, 30–4222, 30–4023, 30–4224, 30–4060, 30–4063, 30–2280, 30–3793, 30–4235, 30–2540), 500–1–4, 500–1–5, and 500–1–28).

The comments of the National Automobile Dealers Association are representative of the comments received on the general issue of the vagueness of the proposed definitions:

> To the extent that the ergonomics rule remains inexorably tied to the reporting of MSD risks, MSD symptoms, MSDs, OSHA recordable MSDs, and covered MSDs, [automobile] dealers will be forced to closely scrutinize reported MSD signs and symptoms, to screen out those that are not tied to real MSDs, and to avoid identifying OSHA recordable MSDs. To be sure, proposed section 1910.145 lists somewhat helpful definitions for each of these terms. Nonetheless, these definitions are lacking in that they fail to provide sufficient guidance to enable dealers to make practical, cost effective, and objective determinations (Ex. 4839).

Some commenters were concerned that the terms lacked objective criteria (see, *e.g.,* Exs. 32–206–1, 30–3765, 30–1722, 30–4185, 30–3826, 30–4538, 32–300–1, 30–3336, 30–2208–1, 30–3853, 30–3749, and 30–3167). Some commenters suggested that OSHA should use definitions for certain terms that had been established by outside organizations (see, *e.g.,* Exs. 30–3765, 30–4499, and 30–3167). Another commented that there was no consensus definition on many of the terms; that experts are not in agreement on the root cause and true definition of MSDs; and that scientists find it difficult to explain why different individuals working on the same job will not experience the same symptoms (Ex. 30–3167). Some of the commenters disagreed with the way the terms were defined or offered suggested alternatives (see, *e.g.,* Exs. 30–3765, 30–4185, 30–3826, 30–2208–2, 30–1722, 32–111–4, 30–4538, 30–3934, 32–198–4, 32–300–1, 30–2208, 30–4499, 30–3818, 30–3000, 31–242, 30–4499, 30–3867, 30–3818 and 30–434).

The Department of Defense (DoD) (Ex. 30–3826) suggested that OSHA eliminate the need for many of the definitions, such as those for manufacturing jobs, manual material handling, and several terms used within those definitions, by simply including all general industry employers in the scope of the standard. OSHA notes that the scope of the final rule has been revised so that it is no longer necessary to define ''manufacturing jobs'' and ''manual handling jobs.'' (See the summary and explanation discussion on Scope, paragraph (b).)

Some commenters argued that the definitions' vagueness meant that OSHA's cost estimates would be substantially underestimated because employers would do ''everything'' in an attempt to comply (see, *e.g.,* Exs. 32–206–1, 32–141–1 and 30–3813). Another commenter questioned whether the rule would result in a substantial reduction in MSDs because it was so unclear (Ex. 32–368–1). Others said that if the standard cannot be understood, it is not legally defensible, citing cases such as *Kent Nowlin Construction Co.* v. *OSHRC, Connally* v. *General Constr. Co.,* and *Diebold Inc.* v. *Marshall* (Exs. 30–1897, 32–206–1, 32–368–1 and 30–3336).

In response to these comments, OSHA has redefined many terms in the final rule, deleted others, and provided greater clarity in several areas that were particularly singled out for comment such as the level of control employers must reach. Revised provisions of the final rule that provide definite compliance endpoints and ''safe harbors'' for employers are examples of these changes. The issue of ''fair notice'' (vagueness) is discussed in the section of the preamble entitled ''Other Statutory Issues''. Thus the final rule addresses the concerns of employers by providing objective criteria and establishing clear obligations for employers to follow.

Specific Comments on Definitions

Administrative controls are defined as changes in the way that work in a job is assigned or scheduled that reduce the magnitude, frequency, or duration of exposure to ergonomic risk factors. Examples of administrative controls include employee rotation, employer-designated rest breaks designed to reduce exposure, broadening or varying job tasks (job enlargement), and employer-authorized changes in work pace.

The definition of the term *administrative controls* is essentially unchanged from the proposal. OSHA received one comment on the definition (Ex. 30–3748), which noted that the proposed definition was clear.

The term *Control MSD hazards* means to reduce MSD hazards to the extent that they are no longer reasonably likely to cause MSDs that result in work restrictions or medical treatment beyond first aid. This is a new term in the final rule. OSHA has included a definition for this term in the final rule because paragraph (k) of the standard requires employers to control MSD hazards. Controlling hazards means that the risk factors that were occurring at a magnitude, duration, or frequency sufficient to cause an MSD hazard have been reduced to the extent that they are no longer reasonably likely to cause MSDs that result in work restrictions or medical treatment beyond first aid. Employers are to use engineering, work practice, or administrative controls or personal protective equipment to control MSD hazards.

The proposed rule contained two similar terms—''eliminate MSD hazards'' and ''materially reduce MSD hazards.'' Commenters alleged that these terms were vague and incapable of quantification (see, *e.g.,* Exs. 30–1897, 32–206–1, 32–368–1, 30–3765, 30–1101 and 30–2986). Statements in the record said that the term ''eliminate MSD hazards'' should not be used because it is not possible to eliminate hazards so completely that MSDs will no longer occur. There will always be ergonomic risks, according to these commenters (see, *e.g.,* Ex. 30–3765). In addition, there were statements that the term ''eliminate MSD hazards'' is not really different from ''materially reduce MSD hazards'' (see, *e.g.,* Ex. 32–300–1). Comments on the term ''materially reduce MSD hazards'' stated that employers would not be able to evaluate whether or not material reductions in risks have occurred and expressed concern that the term could be interpreted differently by employers, employees, and OSHA inspectors (see, *e.g.,* Ex. 30–3845). Some commenters also objected to some of the phrases used in the proposal definition of ''materially reduce MSD hazards,'' such as ''magnitude,'' ''likelihood,'' and ''significantly'' (see, *e.g.,* Exs. 30–1897, 30–3765, 30–3866, 32–300–1, 30–4467).

In response to comments in the record, OSHA has decided to delete the terms ''eliminate MSD hazards'' and ''materially reduce MSD hazards'' from the final rule. Instead, the Agency has defined ''control MSD hazards'' more clearly and has additionally provided clear compliance endpoints that essentially cure the vagueness objections raised.

OSHA also received a comment from the Department of Defense (Ex. 30–3826), which recommended that definitions be developed for ''interim'' and ''permanent controls,'' stating:

> The timetable in [proposed] § 1910.943 included reference to ''(e) interim controls'' and ''(g) permanent controls''; however, there are no corresponding sections nor definitions within section 1910.945 that discusses their distinction. At what point does an interim control become a permanent control, especially when the employer is following the incremental abatement process guidance contained within 1910.922. * * * According to some sources, the only permanent control for ergonomic hazards is an engineering control—administrative and work practice controls can almost always be circumvented in the name of convenience, schedule or production. Unfortunately, in many cases, there are no feasible engineering controls for identified ergonomic hazards. Therefore, permanent controls must be defined, and criteria for determining whether an employer has fulfilled the requirement must be identified (Ex. 30–3826).

The final rule does not use the term ''interim'' controls. The terms used in the standard, ''initial controls'' and ''permanent controls,'' are self-explanatory; they are discussed in the summary and explanation for paragraph (m).

The term *Employee representative* means a person or organization that acts on behalf of an employee. This term was not defined in the proposal, but is included in the final rule for clarification. Additional discussion relating to the meaning of this term can be found in the summary of explanation of paragraph (i).

Engineering controls are defined in the final rule as physical changes to a job that reduce MSD hazards. Examples of engineering controls include: changing, modifying, or redesigning workstations, tools, facilities, equipment, materials, or processes.

The definition of the term ''engineering controls'' has been changed from the proposal. In the proposal, OSHA defined engineering controls as physical changes that eliminated or *materially reduced* the presence of MSD hazards, a term also defined in the proposal. OSHA defined the term ''materially reduce MSD hazards'' to mean ''to reduce the duration, frequency and/or magnitude of exposure to one or more ergonomic risk factors in a way that is reasonably anticipated to significantly reduce the likelihood that covered MSDs will occur.'' (See the discussion of these terms above, in the section on ''Control MSD hazards.'') One commenter stated that the definition of engineering controls was clear (Ex. 30–3748).

The term *Follow-up* means the process or protocol an employer or HCP uses (after a work restriction is imposed) to check on the condition of employees who have experienced MSD incidents. The definition of the term ''follow-up'' is essentially the same as the proposed definition, except that OSHA has removed a sentence from the proposed definition that explained why ''follow-up'' was necessary. The sentence removed was ''Prompt follow-up helps to ensure that the MSD is resolving and, if it is not, that other measures are promptly taken.'' No substantive comments on this definition were received. Additional discussion relating to the meaning of this term can be found in the summary and explanation for paragraph (p).

Health care professionals (HCPs) are physicians or other licensed health care professionals whose legally permitted scope of practice (*e.g.,* license, registration or certification) allows them to provide independently or be delegated the responsibility to provide some or all of the MSD management requirements of this standard. This definition is identical to the definition in the proposed rule.

One commenter asked OSHA to clarify the definition to specify which occupations (physician, nurse, physical therapist, *etc.*) were included in the term ''HCP'' (Ex. 30–74). Others were of the opinion that the definition was too broad (*see, e.g.,* Exs. 30–991, 30–3004, 30–3934, 30–3937, 30–2208 and 32–22).

The comments of the Combe Company are representative: ''[b]y allowing persons who do not even have a medical degree to diagnose and treat these disorders, the proposed standard creates an environment where the potential for misdiagnosis and improper treatment efforts is dramatically increased'' (Ex. 30–3004). In response to these comments, OSHA notes, first, that the final rule's MSD management section does not require the diagnosis and treatment of MSDs; these medical aspects of MSDs are left to the workers' compensation system, as they always have been. The MSD management envisioned by the standard entails the evaluation of an MSD to identify the need for work restrictions and follow-ups to ensure that recovery is progressing. Second, the Agency is deferring to the states on the issue of permitted scopes of practice; that is, different states permit different HCPs to perform different healthcare activities, and employers are expected to ascertain that the HCPs they rely on to carry out the MSD management responsibilities under the standard are licensed, registered, or certified to perform these functions.

Commenters proposed an alternative definition of HCP, *i.e.,* that in addition to requiring licensing, OSHA require HCPs to have sufficient training and experience in diagnosing and treating MSD injuries/illnesses (*see, e.g.,* Exs. 30–3934 and 30–3937). Another organization pointed out that because the definition is so broad, it could include occupations such as emergency medical technicians or licensed vocational nurses who would not be the appropriate professionals to make decisions with respect to MSDs (Ex. 30–2208). The New Mexico Workers' Compensation Administration argued that under the proposed definition, a massage therapist could render an opinion on MSDs (Ex. 32–22). Again, OSHA is confident that the state scope of practice laws that govern HCPs will ensure that only appropriate personnel are permitted to carry out the standard's MSD management functions.

Some commenters urged OSHA to limit the term HCP only to physicians on the grounds that fact finders rely heavily on treating physician's opinions when litigating causation issues under the various workers' compensation laws (*see, e.g.,* Exs. 30–3749, 30–3344 and 30–4674). OSHA's medical management provisions are independent of and unrelated to the workers' compensation system's procedures for determining medical treatment, or extent-of -disability determinations (see the discussion in the summary and explanation for paragraphs (p), (q), (r), and (s)).

The American College of Occupational and Environmental Medicine (ACOEM) recommended that the definition of health care professional be changed to ''*occupational* physicians or other licensed *occupational* health care professionals,'' to focus on the HCP's training and competencies in occupational medicine. OSHA has not revised the definition of HCP in this standard, although OSHA believes that many employers recognize and only rely on the expertise of occupational physicians and nurses. OSHA's more recent standards (*see, e.g.,* the Respirator standard and the Methylene Chloride standard) have used the term HCP, and have defined it in the same way as in this ergonomics standard; changing it would thus be inconsistent with recent usage. The other issues raised by ACOEM—such as the kinds of activities encompassed by the term MSD management—are discussed in the summary and explanation for that paragraph (paragraph p).

The American Society of Safety Engineers (ASSE) (*see, e.g.,* Ex. 30–386) asked OSHA to include a definition of ''safety professionals'' in the rule and to acknowledge the important role of these professionals in ergonomics programs. The preamble to the final rule does so, and specifically mentions the role of safety professionals, industrial hygienists, and other safety and health professionals in ergonomics program implementation.

The term *Job* is defined in the final rule to mean the physical work activities or tasks that an employee performs. For the purpose of this standard, OSHA considers jobs to be the same if they involve the same physical work activities or tasks, even if the jobs that require those activities or tasks have different titles or job classifications. OSHA is retaining the definition for the term ''job'' unchanged from that in the proposed rule, except for the addition of the word ''tasks''.

Comments on the definition of ''job'' in the proposal stated that the definition gave little guidance on how employers were to determine whether jobs were the same (Ex. 30–3784) and that OSHA should change the word ''job'' or ''job based'' to ''task'' or ''task based'' (Exs. 30–3765 and 30–3826). The Department of the Navy (Ex. 30–3818) also recommended that OSHA focus on job tasks rather than the job because the term ''job'' is frequently associated with titles and position descriptions. The Department of the Navy also asked OSHA to define the word ''task'' in the final rule. OSHA believes that the final rule's definition of a job as the physical activities or tasks that an employee performs is responsive to the Navy's concerns. For a discussion of the meaning of tasks in the context of job hazard analysis, see the summary and explanation for paragraph (j). In addition, the presence of the Basic Screening Tool will enable employers to identify jobs that are the same, despite, for example, differences in job titles.

Musculoskeletal disorders (MSDs) is defined in the final rule as:

> a disorder of the muscles, nerves, tendons, ligaments, joints, cartilage, blood vessels, or spinal discs. For purposes of this standard, this definition only includes MSDs in the following areas of the body that have been associated with exposure to risk factors: neck, shoulder, elbow, forearm, wrist, hand, abdomen (hernia only), back, knee, ankle, and foot. MSDs may include muscle strains and tears, ligament sprains, joint and tendon inflammation, pinched nerves, and spinal disc degeneration. MSDs include such medical conditions as: low back pain, tension neck syndrome, carpal tunnel syndrome, rotator cuff syndrome, DeQuervain's syndrome, trigger finger, tarsal tunnel syndrome, sciatica, epicondylitis, tendinitis, Raynaud's phenomenon, hand-arm vibration syndrome (HAVS), carpet layer's knee, and herniated spinal disc. Injuries arising from slips, trips, falls, motor vehicle accidents, or similar accidents are not MSDs.

The definition of ''musculoskeletal disorder (MSD)'' in the final rule differs somewhat from the proposed definition. The final rule limits the definition to those MSDs involving certain body parts: the neck, shoulder, elbow, forearm, wrist, hand, abdomen (hernia only), back, knee, ankle and foot. This definition, and the purpose paragraph (paragraph (a)) both also make clear that this standard does not cover injuries caused by slips, trips, falls, motor vehicle accidents, or other similar accidents (*e.g.,* being caught in moving parts). OSHA has made these changes in response to criticisms that the proposed definition was too broad (*see, e.g.,* Ex. 30–1216, 30–2035, 30–3866, 30–4821, 32–208–1, 32–368–1, 30–3937, 500–1–116, Tr. 15310).

Some commenters raised issues about the MSDs covered by the standard and their relationship to psychosocial effects and non-occupational factors (*see, e.g.,* Exs. 500–1–1116, 30–3211, 30–3866). These comments and issues are discussed in the Health Effects section of the preamble, Section V, rather than in this definitions section.

Other commenters objected because the acronyms MSD and MSDs are similar to MSDS, which stands for the Material Safety Data Sheets required by OSHA's hazard communication standard, 29 CFR 1910.1200 (see, *e.g.,* Exs. 30–2041 and 30–0522). However, because ''musculoskeletal disorder'' is the scientifically correct term for these conditions and MSD is the widely known abbreviation for the term, OSHA continues to use both ''musculoskeletal disorders'' and its acronym in the final rule.

Some commenters urged OSHA to add other examples such as thoracic outlet syndrome to the list of examples accompanying the definition (see, *e.g.*, Exs. 30–2825 and 30–3332). The list of MSDs included in the final rule is only a list of examples; OSHA recognizes that there are many other MSDs, such as thoracic outlet syndrome, that could be included in this list.

There was some comment that OSHA should adopt a definition of MSDs developed by other organizations such as NIOSH (see, *e.g.*, Exs. 30–3211 and 30–3765). For example, the Dow Chemical Company (Ex. 30–3765) recommended that OSHA adopt the NIOSH definition of MSD and the Society for Human Resource Management (Exs. OR–364, Tr. 15310–15311) suggested that OSHA rely on a medical definition of MSD, such as one taken directly from *Merck's Manual.*

OSHA's definition of MSD is, in fact, very similar to NIOSH's definition, as reflected in the Institute's publication, *Elements of Ergonomics Programs* (DHHS, Publication No. 97–117), particularly with respect to the soft tissues included and the exclusion of accidental injuries.

MSD hazard means the presence of risk factors in the workplace that occur at a level of magnitude, duration, or frequency that is reasonably likely to cause MSDs that result in work restrictions or medical treatment beyond first aid. The definition of ''MSD hazard'' in the final rule differs from the definition in the proposed rule; it has been revised for clarity, as requested by some commenters (see, *e.g.*, Ex. 30–2986). Other commenters found the proposed definition of MSD hazards circular (see, *e.g.*, Exs. 30–3344 and 30–4674). The revised definition addresses this concern, because it focuses on the magnitude, frequency, and duration of identified risk factors and their relationship to MSD hazards.

MSD incident means an MSD that is work related, requires time away from work, restricted work, or medical treatment beyond first aid, or involves MSD signs or MSD symptoms that last 7 or more consecutive days. (See the discussion of the terms MSD signs and MSD symptoms below.) The definition of MSD incident is new to the final rule. See the summary and explanation section describing the provisions of paragraph (e), in which the term ''MSD incident'' is used in association with the standard's action trigger.

MSD signs are objective physical findings that an employee may be developing an MSD. Examples of MSD signs are: decreased range of motion; deformity; decreased grip strength; and loss of muscle function. The final rule's definition is essentially the same as the proposed definition, except for minor editorial revisions made for clarity. Additional discussion of this term appears in the summary and explanation for paragraph (d) regarding the reporting of MSD incidents, paragraph (e), the action trigger, and the Health Effects section of the preamble (Section V).

Most of the comments OSHA received on the list of examples of MSD signs included in the proposal concerned the role of the health care professional (HCP) and the phrase ''objective physical findings'' (see, *e.g.*, Exs. 30–3818, 30–3826, 30–3934, 30–2993, 30–3167, 30–3745, 30–4814 and 30–434). These commenters argued that the rule should be structured so that only an HCP, not the employer, can determine whether a given MSD is associated with objective physical findings. The Newspaper Association of America objected to the list of signs because ''[O]SHA has inexplicably chosen to provide only four examples of MSD signs and leaves employers to guess at what may constitute objective physical findings'' (Ex. 30–2986). In response, OSHA notes that employers are always free to involve an HCP in their determinations. However, OSHA does not believe that employers will generally have difficulty deciding whether an MSD sign is related to an employee report because, by definition, signs are visible indications observable both by the employee and the employer.

MSD symptoms are defined in the final rule as physical indications that an employee may be developing an MSD. Examples of MSD symptoms are: pain, numbness, tingling, burning, cramping, and stiffness. The final rule's list of examples is essentially the same as the list in the proposal, except that it is more clearly written. Most of the comments relating to this term have already been discussed above under ''musculoskeletal disorder.'' Additional discussion of this term appears in the summary and explanation for paragraph (e) on the reporting of MSD incidents.

Personal protective equipment (PPE) is the equipment employees wear that provides a protective barrier between the employee and an MSD hazard. Examples of PPE are vibration-reduction gloves and carpet layer's knee pads. The final rule's definition is essentially identical to the definition proposed, except that the word ''effective'' before ''protective barrier'' has been deleted because the effectiveness of PPE depends on the circumstances in a particular workplace and is therefore not appropriate for a definition. One commenter noted that the definition of PPE was clear. Additional discussion relating to the meaning of this term can be found in the summary and explanation of paragraph (l).

Problem job means a job that the employer has determined poses an MSD hazard to employees in that job. The definition of the term ''problem job'' has been changed from the definition in the proposal, which defined a problem job as ''* * * a job in which a covered MSD is reported. A problem job also includes any job in the workplace that involves the same physical work activities and conditions as the one in which the covered MSD is reported, even if the jobs have different titles or classifications.'' (See the definition of the term ''job'' above.)

Commenters were concerned that the definition unnecessarily expanded the scope of the standard (see, *e.g.*, Exs. 32–206–1, 32–368–1, 30–294, 30–2208–1, 30–3284 and 31–336), or requested clarification of ways an employer could use to determine when physical work activities and conditions were the ''same'' (see, *e.g.*, Ex. 30–3765).

In response, OSHA notes that the Agency intends the ''same job'' requirements to extend the protections provided by the standard to employees who are fortunate enough not to have experienced an MSD incident but who are in ''higher-risk'' jobs, as demonstrated by the fact that one employee in the job has already experienced an incident and the job has been determined to meet the action trigger. The standard's ''same job'' requirements are preventive in nature and will benefit workers in the job as well as saving the employer the costs associated with the MSDs that are averted by fixing the jobs of other employees in the same job. As to the concern about how an employer can know which jobs are the same, OSHA believes that the Basic Screening Tool will be useful in cases where deciding which jobs are the same is difficult.

Risk factor, as used in this standard, means force, awkward posture, repetition, vibration, and contact stress. The term replaces the term ''ergonomic risk factors,'' which was defined in the proposed rule. There was considerable comment in response to the definition of ''ergonomic risk factors'' in the proposed rule. Commenters stated that the term was vague and too broad (see, *e.g.*, Exs. 30–1011 and 30–2986) and did not provide employers with enough information to allow them to determine if the factors are present in particular jobs and, if so, the duration of exposure to them (see, *e.g.*, Ex. 30–2986). A large number of commenters expressed concern that they would be unable to quantify the risk factors in a job based on the amount of information provided in the proposal (see, *e.g.*, Exs. 30–1722, 30–3032, 30–3336, 30–3765, 30–3813 and 30–3866).

The concerns raised by commenters have largely been addressed by the final rule, which limits the number of risk factors covered by the standard to those most often associated with MSDs and additionally provides clear definitions for each risk factor of the magnitude, frequency, or duration at which exposure poses a potential risk (the Basic Screen levels) and the level deemed to pose an MSD hazard (*e.g.*, the levels indicated by the hazard identification tools in Appendices D–1 and D–2).

Some commenters raised legal issues, *i.e.,* the alleged vagueness of the term ''risk factors'' and the lack of precise quantitative estimates of the levels at which each risk factor poses risk (see, *e.g.*, Exs. 32–368–1 and 32–206–1), and the perceived need to establish quantitative permissible exposure limits for the risk factors (see, *e.g.*, Ex. 30–3784). These issues are discussed at length in the Other Stautory Issues and Legal Authority sections of this preamble.

Work practices are changes in the way an employee performs the physical work activities of a job that reduce exposure to MSD hazards. Work practice controls involve procedures and methods for safe work. Examples of work practice controls for MSD hazards include:

(a) Using neutral work postures;
(b) Using lifting teams;
(c) Taking micro-breaks; and
(d) Avoiding lifts involving extended reaches or twisted torso.
(e) Conditioning or work-hardening programs.

The proposed rule defined work practices in essentially the same way, except that OSHA has added a conditioning or work-hardening program to the rule in response to comments in the record (see, *e.g.,* Exs. 30–1902, 30–3686, 32–22, and 32–210, and 30–4137, Tr. 8720, Tr. 12472–12479). These commenters stated that they use these program to protect newly assigned workers during the period when they are first exposed to risk factors on the job. OSHA notes in the definition for ''work restrictions'' that conditioning and work-hardening programs are not to be considered work restrictions for the purposes of this standard.

In the Issues section of the proposal, OSHA asked for comment about the appropriate work practices or controls employers could use to prevent Computer Vision Syndrome (CVS). In response to this inquiry, OSHA received several comments (see, *e.g.,* Exs. 30–3032, 30–2387, 30–2208). One commenter stated that controlling glare, providing adequate lighting, well-designed software, and regularly shifting the static fixed focal point of the eye are all approaches that have been used to address CVS. Other commenters (see, *e.g.,* Exs. 30–3032, 30–2208) urged OSHA not to include CVS in the list of examples of MSDs in the final rule. OSHA agrees that not enough is currently known about CVS and its causes for the final rule to focus on it.

Work related means that an exposure in the workplace ''caused or contributed'' to an MSD or ''significantly aggravated'' a pre-existing MSD. ''Work-related'' was not defined in the proposal. The final rule uses the term ''work related'' in the definition of an MSD incident. In the proposed rule, OSHA used the term ''work relatedness'' in the definitions of ''covered MSD'' and ''OSHA recordable MSD.''

A number of commenters objected to the term ''work-related'' in the context of OSHA recordable injuries and illnesses because they believe the term is so broad that it often includes non-work related MSDs (see, *e.g.,* Exs. 500–188, 30–2489, 31–336, 30–2834, 30–2986, 30–1722 and 30–1037). For example, the Center for Office Technology argued that the proposal was designed in a way that would permit a program to be triggered by an episode of weekend overexertion that interfered with work on Monday (Ex. 30–2208–2), and the International Council of Shopping Centers (Ex. 30–2489) expressed the same concern. These commenters are essentially objecting to OSHA's definition of a recordable injury under Part 1904, the Agency's recordkeeping rule; that rule defines a work-related injury as one caused, contributed to, or aggravated by an event or exposure in the workplace, without regard to the extent of the contribution of work to the injury.

Several participants urged OSHA not to include the concept of work aggravation of a pre-existing MSD in the final rule (see, *e.g.,* Exs. 30–629, 30–1037, 30–3159, 30–4185 and 31–336). Typical of those comments was one by Uniservice, Inc. (Ex. 30–2834), which stated, ''[w]e will have to make changes to fix a job for a supposed MSD that was not caused by workplace exposure in the first place [if OSHA includes the significant aggravation definition in the standard].'' Other commenters focused their concern about including aggravation in the concept of work-relatedness on back injuries because back pain is so common both inside and outside the workplace (see, *e.g.,* Exs. 30–3784, 30–4185, 31–336 and 30–3937). The final rule does not rely on an OSHA recordable injury or illness when defining an MSD incident; the final rule's definition specifies what kinds of MSDs are included (those involving restricted work, for example). OSHA believes that the increased clarity of the final rule will alleviate many of these commenters' concerns.

Work restriction protection (WRP) means the maintenance of the earnings and other employment rights and benefits of employees who are on temporary work restrictions. Benefits include seniority, insurance programs, retirement benefits, and savings plans. In the proposal, OSHA defined ''work restriction protection'' to mean:

> the maintenance of the earnings and other employment rights and benefits of employees who are on temporary work restriction. For employees who are on restricted work activity, WRP includes maintaining 100% of the after-tax earnings employees with covered MSDs were receiving at the time they were placed on restricted work activity. *For employees* who have been removed *from the workplace,* WRP includes maintaining 90% of the after-tax earnings. Benefits mean 100% of the non-wage-and-salary value employees were receiving at the time they were placed on restricted work activity or were removed from the workplace. Benefits include seniority, insurance programs, retirement benefits and savings plans.

The language beginning with ''For employees'' and ending with ''from the workplace'' (outlined in the above quote) has been removed from the final rule's definition. Additional discussion relating to both the meaning of this term and the regulatory requirements on work restriction protection can be found in the summary and explanation of paragraph (r).

Work restrictions are defined as limitations, during the recovery period, on an employee's exposure to MSD hazards. Work restrictions may involve limitations on the work activities of the employee's current job (light duty), transfer to temporary alternative duty jobs, or time away from the workplace to recuperate. For the purposes of this standard, temporarily reducing an employee's work requirements in a new job in order to reduce muscle soreness resulting from the use of muscles in an unfamiliar way is not a work restriction. Further, the day an employee first reports an MSD is not considered a day of work restriction, even if the employee is removed from his or her regular duties for part of the day.

This definition is a revision of the proposed definition. The proposed definition of work restriction included the sentence: ''To be effective, work restrictions must not expose the injured employee to the same MSD hazards as were present in the job giving rise to the covered MSD.'' This sentence has been removed from the definition because it is better suited to the summary and explanation for paragraph (r). See the discussion of the comments received on Work Restriction Protection in general above and in the summary and explanation for paragraph (r).

You means the employer, as defined by the Occupational Safety and Health Act of 1970 (29 U.S.C. 651 *et seq.*). The final rule's definition is identical to the proposed definition (64 FR 66078). There were no comments on this definition.

Several terms that were defined in the proposal are not used in the final rule. They include ''manual handling jobs,'' ''manufacturing jobs,'' and ''have knowledge.'' ''MSD management'' was also defined separately in the proposal but is now discussed in the regulatory text and summary and explanation for paragraph (p).

Some commenters suggested that OSHA define new terms, including the term ''employee.'' The Alliance of American Insurers (AAI) (Ex. 30–3751) objected to the proposal's cross-reference to the definition of employee contained in the OSH Act. The Alliance asked OSHA to provide additional clarification about who is or is not an employee under various types of employer/employee relationships, such as employee leasing arrangements. The AAI said: ''how is OSHA to make WRP determinations? What if one entity is held to be responsible for WRP but the other entity is responsible for workers' compensation benefits?'' This issue is discussed in detail in the summary and explanation for paragraph (r).

The DuPont SHE Excellence Center (Ex. 30–2134) recommended the addition of a definition for *workplace,* commenting that in the proposed rule:

> ''There is no definition of workplace incorporated in this section [proposed definition of problem job], which creates more confusion. Is the workplace the specific building the job is located, the same physical site (which might contain several buildings), or the entire company with all of its locations within the U.S. and its territories? Some jobs take place out-of-doors, in varied locations which can move from place to place. How are these jobs considered under the ''problem job'' definition?''

The final rule makes clear that the physical establishment that houses the problem job, or to which the injured employee and other employees in the same job report, limits the program activities required by the standard. The standard does not impose corporate-wide obligations on businesses that have multiple establishments. Instead, the standard is job-based in the first instance, *i.e.,* employers are only required to implement the ergonomics program in those jobs identified as problem jobs. It is establishment-based in the second instance, *i.e.,* employers are only required to include in their program the problem job (and the workers in them) within the establishment to which the problem job is ''attached.'' This means that, where the workforce is mobile, the establishment to which the injured employee reports would be considered the establishment, for the purposes of the standard. Since the standard requires employers to extend the standard's protections to all employees in the same job, the employer is required to ''fix'' the MSD hazards in the workstations or work environments of all employees in the same job who are located in, or report to, the same establishment.

For the purposes of the standard, OSHA defines an establishment as a single physical location where business is conducted or where services or industrial operations are performed. For activities where employees do not work at a single physical location, such as construction; transportation; communications, electric, gas and sanitary services; and similar operations, the establishment is represented by main or branch offices, terminals, stations, etc., that either supervise such activities or are the base from which personnel carry out these activities.

One commenter (Exs. 30–2825 and 30–3332) suggested that OSHA add a definition of *repetitive motion jobs* to the final rule. OSHA does not believe such a definition is necessary because the final rule contains clear definitions of each of the risk factors (see the Basic Screening Tool in Table 1).

Several commenters asked OSHA to clarify the definitions of industries covered and exempted from the final rule (see, *e.g.,* Exs. 30–1897, 30–3818 and 30–4716). For example, the Honorable James Talent, Chairman of the U.S. House of Representatives Committee on Small Business (Ex. 30–1897), noted that the proposed rule did not apply to agriculture, construction, or maritime operations, but did not clarify each of these terms. Paragraph (b) of the final rule provides clear definitions of the standard's scope and explicitly states that it does not apply to maritime, agricultural, railroad, or construction employment.

Finally, some commenters suggested that OSHA define the term *recovery period,* which was used in the definition of work restriction protection (WRP) (see, *e.g.,* Exs. 30–3749 and 30–3344). OSHA has not done so because this term is used in the final rule in its everyday sense, and is therefore clear on its face.

V. Health Effects

In this section, OSHA presents the evidence contained in the rulemaking record that addresses the causal relationship between exposure to biomechanical risk factors at work and an increased risk of developing musculoskeletal disorders (MSDs). This evidence consists of epidemiological studies of exposed workers in diverse occupational settings, biomechanical studies describing the relationships between exposure to risk factors and associated forces imposed on musculoskeletal tissue, studies of tissue pathology describing the kinds of tissue alterations that have been seen to result from such forces, and medical and diagnostic information relating to MSDs. In making its findings from this evidence, OSHA is relying in part on the extensive scientific evidence presented in the detailed Health Effects Appendices to the proposal (64 FR 65865–65926) (Ex. 27–1), located on OSHA's webpage at *http://www.osha.gov* and summarized in this section. In addition, OSHA's analysis includes results from several other studies placed into the rulemaking record after publication of the proposed rule, as well as comment and testimony from many distinguished scientific experts.

This section is divided into the following seven parts:

- Part A, Description of Biomechanical Risk Factors;
- Part B, Overview of the Health Effects Evidence;
- Part C, Evidence on Neck and Shoulder Disorders;
- Part D, Evidence on Upper Extremity Disorders;
- Part E, Evidence on Back Disorders;
- Part F, Evidence on Lower Extremity Disorders; and
- Part G, OSHA's Response to Issues Raised in the Rulemaking.

A. Biomechanical Risk Factors

Biomechanical risk factors are the aspects of a job or task that impose a physical stress on tissues of the musculoskeletal system, such as muscles, nerves, tendons, ligaments, joints, cartilage, spinal discs, or (in the case of hand-arm vibration syndrome) blood vessels of the upper extremities. To accomplish motion and work, muscle, nerves, connective tissue, and skeleton are affected by a number of external and internal physical demands causing metabolic and compensatory tissue reactions. External demands can include direct pressure on tissues or tissue friction. Internal responses can include inflammatory responses to tissue injury, neurochemical changes, and altered metabolism. The consequences of these external and internal demands associated with work activities can include a spectrum of symptoms or clinical findings. Although some types of tissue, like skeletal muscle, have the ability to recover after an injury that does not physically disrupt the tissue, exceeding tissue limits may result in permanent damage to a tissue. However, skeletal muscle is just one type of tissue that can be affected; other tissues like tendon, ligament, nerve, and cartilage can also be damaged by exposure to excessive physical task factors. These tissues, unlike skeletal muscle, do not have the same capacity for recover and repair after injury. (Each part of this Health Effects section briefly summarizes the pathogenesis of MSDs; OSHA's Health Effects Appendices (Ex. 27–1), developed for the proposed rule, contains detailed discussions of the scientific literature describing the pathogenesis of MSDs).

The biomechanical risk factors addressed by this final rule are repetition, force, awkward postures, vibration to the upper extremity (*i.e.,* segmental vibration), and contact stress. In occupations where an increased prevalence or incidence of MSDs has been observed, these risk factors frequently occur in combination; the level of risk associated with exposure depends on the intensity and duration of exposure as well as the amount of recovery time available to the strained tissues for repair. Soft tissues of the musculoskeletal system will develop tolerance to physical loading if sufficient recovery time is provided. Without adequate recovery time, affected tissues can accumulate damage or become more prone to failure. The need for adequate recovery time between exposure events means that the pattern of exposure also has an important influence on risk. The biomechanical risk factors covered in the final rule are force, repetition, awkward postures, contact stress, and segmental vibration; the basic screening tool in the final rule describes criteria for each of these risk factors that identifies those jobs where there is a potential risk of MSDs. Each of these risk factors is described below.

Force

Force refers to the amount of physical effort that is required to accomplish a task or motion. Force also refers to the degree of loading to muscles and other tissues as a result of applying force to perform work. Tasks or motions that require application of higher force place higher mechanical loads on muscles, tendons, ligaments, and joints (Ex. 26–2). The force required to complete a movement increases when other risk factors are also involved. For example, more physical effort may be needed to perform tasks when the speed or acceleration of motions increases, when vibration is present, or when the task also requires awkward postures. Hand tools that require use of pinch grips require more forceful exertions to manipulate the tool than do those that permit use of power grips.

Relationships among external loads, internal tissue loads, and mechanical and physiological responses have also been studied extensively, using simulation, direct instrumentation, indirect instrumentation, and epidemiological studies. In a report on the Research Base of Work-Related Musculoskeletal Disorders prepared by the National Research Council (NRC) in response to a request from the National Institutes of Health (NIH) (Ex. 26–37), the steering committee provides some rationale for evaluating and controlling biomechanical risk factors, specifically force:

- The concept of force can be generalized to encompass numerous ways of measuring and characterizing external loads. For example, force can be measured in terms of the weight of parts, tool reaction force, perceived exertion, muscle electrical activity, or observer ratings.
- Internal loads can be estimated by using external loads. For example, a worker must bend or stoop to lift something from the floor; a worker will exert more force on a stiff keyboard than a light touch keyboard. Understanding these relationships allows prediction of internal loads.
- Predicted internal loads generally agree with measured internal and external loads. For example, measurements of muscle loads during activity using electromyography generally agree with predicted values.

Force can be assessed qualitatively or quantitatively. Quantitative measures include strain gauges, spring scales, and electromyography to measure muscle activity. A qualitative assessment of force is based on direct observation of the amount of physical exertion required to complete a task, and is usually graded on an ordinal scale (*i.e.,* low, medium, high).

Repetition

Repetition refers to the frequency with which a task or series of motions are repeated with little variation in movement. Although force and/or awkward postures can combine with repetition to increase the risk of MSDs over that of repetition alone, acceleration and velocity of repetitive movement are also important considerations in that they may ''cause damage that would not be predicted by muscle forces or joint angles alone'' (Washington State CES, p.20, Ex. 500–71–93).

Repetitive motions occur frequently in manufacturing operations where production and assembly processes have been broken down into small sequential steps, each performed by different workers. However, it also applies to many manual handling operations, such as warehouse operations and baggage handling. Repetition is typically assessed by direct observation or videotaping of job tasks. The intensity of exposure is usually expressed as a frequency of motion or as a percent of task cycle time, where a cycle is a pattern of motions.

Awkward Postures

Awkward postures refer to positions of the body (*e.g.,* limbs, joints, back) that deviate significantly from the neutral position while job tasks are being performed. For example, when a person's arm is hanging straight down (*i.e.,* perpendicular to the ground) with the elbow close to the body, the shoulder is said to be in a neutral position. However, when employees are performing overhead work (*e.g.,* installing or repairing equipment, grasping objects from a high shelf) their shoulders are far from the neutral position. Other examples include wrists bent while typing, bending over to grasp or lift an object, twisting the back and torso while moving heavy objects, and squatting. Awkward postures often are significant contributors to MSDs because they increase the exertion and the muscle force that is required to accomplish the task, and compress soft tissues like nerves, tendons, and blood vessels. As used in the final rule's basic screening tool, awkward postures may be either static postures held for prolonged periods of time, or they may occur repetitively.

Awkward posture is the primary ergonomic risk factor to which employees are exposed when the height of working surfaces is not correct. Working at surfaces that are too high can affect several parts of the body. Employees may have to lift and/or move their shoulders, elbows and arms (including hands and wrists) into uncomfortable positions to perform the job tasks on higher surfaces. For example, employees may have to raise their shoulders or move their elbows out from the side of their body to do a task on a high working surface. Also, they may have to bend their heads and necks to see the work they are doing.

Working surfaces that are too high usually affect the shoulders. The muscles must apply considerably more contraction force to raise and hold the shoulders and elbows out to the side, particularly if that position also must be maintained for more than a couple of seconds. The shoulder muscles fatigue quickly in this position.

On the other hand, when surfaces are too low, employees may have to bend their backs and necks to perform their tasks while hunched over the working surface. They may also have to reach down with their arms and backs to do the tasks. Where working surfaces are very low, employees may have to kneel or squat, which places very high forces on the knees to maintain the position and the weight of the body. Working surfaces that are too low usually affect the lower back and occasionally the neck.

Working in awkward postures increases the amount of force needed to accomplish an exertion. Awkward postures create conditions where the transfer of power from the muscles to the skeletal system is inefficient. To overcome muscle inefficiency, employees must apply more force both to initiate and complete the motion or exertion. In general, the more extreme the postures (*i.e.,* the greater the postures deviate from neutral positions), the more inefficiently the muscles operate and, in turn, the more force is needed to complete the task. Thus, awkward postures make forceful exertions even more forceful, from the standpoint of the muscle, and increase the amount of recovery time that is needed.

Awkward postures are assessed in the workplace by observing joint angles during the performance of job tasks. Observed postures can be compared qualitatively to diagrams of awkward postures, such as is done in many job analysis tools, or angles can be measured quantitatively from videotape recordings.

Contact Stress

As used in many ergonomics texts and job analysis tools, contact stress results from activities involving either repeated or continuous contact between sensitive body tissue and a hard or sharp object. The basic screening tool in the final rule includes a particular type of contact stress, which is using the hand or knee as a hammer (*e.g.*, operating a punch press or using the knee to stretch carpet during installation). Thus, although contact stress is covered in the final rule as a single risk factor, it is really a combination of force and repetition. Mechanical friction (*i.e.*, pressure of a hard object on soft tissues and tendons) causes contact stress, which is increased when tasks require forceful exertion. The addition of force adds to the friction created by the repeated or continuous contact between the soft tissues and a hard object. It also adds to the irritation of tissues and/or to the pressures on parts of the body, which can further inhibit blood flow and nerve conduction.

Contact stress commonly affects the soft tissue on the fingers, palms, forearms, thighs, shins and feet. This contact may create pressure over a small area of the body (*e.g.*, wrist, forearm) that can inhibit blood flow, tendon and muscle movement and nerve function. The intensity of exposure to contact stress is usually determined qualitatively through discussion with the employee and observation of the job.

Segmental Vibration

Vibration refers to the oscillatory motion of a physical body. Segmental, or localized vibration, such as vibration of the hand and arm, occurs when a specific part of the body comes into contact with vibrating objects such as powered hand tools (*e.g.*, chain saw, electric drill, chipping hammer) or equipment (*e.g.*, wood planer, punch press, packaging machine).

Although using powered hand tools (*e.g.*, electric, hydraulic, pneumatic) may help to reduce risk factors such as force and repetition over using manual methods, they can expose employees to vibration. Vibrating hand tools transmit vibrations to the operator and, depending on the level of the vibration and duration of exposure, may contribute to the occurrence of hand-arm vibration syndrome or Raynaud's phenomenon (*i.e.* vibration-induced white-finger MSDs) (Ex. 26–2).

The level of vibration can be the result of bad design, poor maintenance, and age of the powered hand tool. For example, even new powered hand tools can expose employees to excessive vibration if it they do not include any devices to dampen the vibration or in other ways shield the operator from it. Using vibrating hand tools can also contribute to muscle-tendon contractile forces owing to operators having to use increased grip force to steady tools having high vibration.

Vibration from power tools is not easy to measure directly without the use of sophisticated measuring equipment. However, vibration frequency ratings are available for many recently designed hand tools.

Based on the whole of the scientific literature available at the time of the proposal, OSHA also identified prolonged sitting and standing (a form of static posture) and whole-body vibration as risk factors for MSDs; in addition, OSHA identified cold temperatures as a risk factor modifier because it could require workers to increase the force necessary to perform their jobs (such as having to grip a tool more tightly) (64 FR 65865–65926) (Ex. 27–1). The final rule does not explicitly include these risk factors. For prolonged standing and sitting, and for cold temperatures, although there is evidence of an increased risk of MSDs with exposure (*e.g.*, see Skov, Ex. 26–674), the available evidence did not permit the Agency to provide sufficient guidance to employers and employees on the levels of exposure that warrant attention. For whole-body vibration, there was substantial evidence of a causal association with low back disorders (*e.g.*, see NIOSH 1997); however, heavy equipment and trucks, the most common sources of whole-body vibration, are seldom rated for vibration frequencies and intensities. In addition, measurement of whole-body vibration levels requires special equipment and training that would be difficult for most employers to obtain. Therefore, OSHA determined that it was appropriate not to include whole-body vibration in the final rule at this time.

For the biomechanical risk factors of force, repetition, awkward postures, segmental vibration, and contact stress, OSHA has concluded that strong evidence exists for a positive relationship between exposure to these risk factors and an increased risk of developing MSDs, based on the scientific evidence and testimony described in this section of the final rule's preamble. The risk factors identified by the Agency as being causally related to the development of MSDs and that are covered in the final rule are the same risk factors that have been addressed by other reputable scientific and regulatory bodies, both nationally and internationally, who face the challenge of either reducing the incidence of MSDs or contributing to the scientific basis for these actions. The two most current and thorough reviews on this topic are NIOSH's Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back (Bernard, 1997; Ex. 26–1) and the National Research Council/ National Academy of Science's Work-Related Musculoskeletal Disorders: Report, Workshop Summary, and Workshop Papers (1999; Ex. 26–37). NIOSH's review focused on repetition, force, posture, and vibration when evaluating epidemiologic evidence for the neck, shoulder, elbow, and hand/ wrist. For the low-back, the authors looked at the evidence for heavy physical work, lifting and forceful movements, bending and twisting (awkward postures), whole body vibration and static work postures. The ''work factors'' identified by the NRC in their report on Work-Related Musculoskeletal Disorders are the same as the ''biomechanical risk factors'' identified by OSHA. Although terms may differ depending upon the part of the body being described, it is easy to see the relationship between heavy physical work and lifting and the concept of force/exertion to the back, for example .

The Steering Committee Report for the NRC workshop on ''Examining the Research Base (for Work-Related MSDs)'', participants agreed there is

> ''enough scientific evidence to confirm that strain on musculoskeletal tissue increases when humans perform activities that involve forceful manual exertions, awkward postures, repetitive or prolonged exertions, exposure to vibrations and exposure to cold temperatures.''

However, in a separate paper prepared for the NRC/NAS workshop, Radwin and Lavender also discuss ''workplace layout,'' ''interactions with objects,'work scheduling'' and other ''workplace design factors,'' as factors that these authors, as well as others, have studied in relation to MSDs. Although there is strong agreement on biomechanical factors associated with MSDs, the science is still evolving with regard to other types of factors. Thus, when sources refer to *biomechanical* risk factors, all literature reviewed from the rulemaking record identified the same basic risk factors, all essentially related to force/exertion, repetition, posture and vibration.

Literature reviews published in the scientific literature also evaluate these same risk factors. Literature reviews of this type use selection criteria to capture the best-designed studies with a particular focus, usually risk factors associated with a specific type of disorder, for analysis. Burdorf and Sorock reviewed 35 articles that evaluated risk factors for back disorders and concluded that lifting or carrying loads (force), whole-body vibration and frequent bending and twisting (awkward postures) were consistently related to work-related low-back disorders (1997; Ex. 500–71–24). In a systematic review of 31 studies, Hoogendoorn et al (1997; Ex. 500–71–32) found strong evidence exists for manual materials handling, bending and twisting (awkward posture), and whole-body vibration as risk factors for back pain, and moderate evidence exists for patient handling and physical work.

In their review of the literature on the role of physical load factors in carpal tunnel syndrome, Viikari-Juntura and Silverstein found an association with carpal tunnel syndrome and forceful, repetitive work, extreme wrist postures and vibration (1999; Ex. 32–339–1–56). Other authors (Ariens *et al.*, 2000; Ex. 500–71–23) found a relationship between neck pain and neck flexion, arm force, arm posture, duration of sitting, twisting or bending of the trunk, hand-arm vibration, and workplace design.

In both written submissions to the record, and in oral testimony, numerous scientific experts confirmed and substantiated OSHA's position that sufficient scientific evidence exists, and is contained in the record, to conclude that workplace exposure to the biomechanical risk factors described above increase the risk for work-related MSDs (Exs. 37–1; 37–2; 37–3; 37–6; 37–8; 38–9; 37–10; 37–13; 37–15; 37–16; 37–17; 37–18; 37–21; 37–27; 37–28; 26–37). Scientists who testified at the hearings also confirmed that each of these risk factors are linked to an increased risk of developing an MSD in exposed workers (Dr. Don Chaffin, University of Michigan, Tr 8254; Dr. Nicholas Warren, University of Connecticut Health Center, Tr.1084–85; Dr. Martin Cherniak, Ergonomics Technology Center of Connecticut, Tr. 1128; Dr. Richard Wells, University of Waterloo, Tr. 1353–54; Dr. Robert Harrison, Tr. 1648; Dr. Amadio, Mayo Clinic, Tr. 9815, 98; Dr. Eckardt Johanning, Eastern New York Occupational and Environmental Health Center, Tr. 16831–33; Dr. Jim McGlothlin, Purdue University, Dr. Malcolm Pope, Tr. 16808; Dr. Margit Bleeker, Tr. 16826). This written and oral testimony from scientific experts provides a compelling case establishing the link between exposure to biomechanical risk factors and an increased risk of MSD incidence.

OSHA heard from a number of scientists and physicians during it's hearing with comments along the lines of that by Dr. Robert Harrison, from the University of California (Tr. 1649–50):

> The jobs and tasks my patients are performing are the ones the literature has identified as high-risk jobs with exposure to many of the same physical risk factors. In fact, my patients are exposed to the identical physical work activities and conditions that have been identified by OSHA as causing excessive exposure to force, frequent repetition, awkward posture, contact stress, vibration and cold temperatures.

The record contains many US and international regulations and guidelines that reflect the same biomechanical risk factors addressed in the final rule; some are listed below:

- National Research Council. (1999) Work-Related Musculoskeletal Disorders: Report, Workshop Summary, and Workshop Papers. National Academy Press. (Ex. 26–37);
- National Institute for Occupational Safety and Health. (1997) Musculoskeletal Disorders and Workplace Factors. Centers for Disease Control and Prevention (Ex. 26–1);
- National Institute for Occupational Safety and Health. (1998) Elements of Ergonomics Programs, A Primer Based on Workplace Evaluations of Musculoskeletal Disorders. (Ex. 26–2);
- European Agency for Safety and Health at Work. Work-related neck and upper limb musculoskeletal disorders (1999). (Ex.500–71–28);
- Department of Labor and Industries, Washington State. (5/25/00) Concise Explanatory Statement, WAC 296–62–051, Ergonomics (Ex. 500–71–93);
- Ergonomics for the Prevention of Musculoskeletal Disorders, Swedish National Board of Occupational Safety and Health on Ergonomics for the Prevention of Musculoskeletal Disorders. AFS 1998:1; (Ex. 500–71–14);
- National Codes of Practice for the Prevention of Occupational Overuse Syndrome-Worksafe Australia [NOHSC:2013(1994)], (Ex. 500–71–2);
- National Standard for Manual Handling and National Code of Practice for Manual Handling, Worksafe Australia. 1990 (Ex. 500–71–4);
- Occupational Overuse Syndrome: Guidelines for Prevention and Management, Occupational Safety and Health Services, Department of Labor, New Zealand (Ex. 500–71–12);
- Ergonomics (MSI) Requirements, British Columbia, Canada (Ex. 32–339–1–6);

• Regulations and Code of Practice, (Manual Handling) Occupational Health and Safety Regulations 1988. Victoria, Canada. (Ex. 500–71–17);
• European Communities Council Directive on Manual Handling (Ex. 32–339–1–12);
• American Conference of Governmental Industrial Hygienists, Threshold Limit Value (TLV) Committee, Nov. 13, 1999. Notice of Intent to Establish a Threshold Limit Value, Hand Activity Level (Ex. 32–339–1–63);
• American Conference of Governmental Industrial Hygienists. 1987. Ergonomic Interventions to Prevent Musculoskeletal Injuries in Industry (Ex. DC–386, Tr. 16291–335);
• American Industrial Hygiene Association. 1994. Ergonomic Guide Series (Ex. 32–133–1);
• American National Standards Institute (ANSI) draft Ergonomic Standard, Z–365 (1998) (Ex.26–1264).

Furthermore, the vast majority of the many job evaluation tools found in the record and reviewed by the Agency collectively address these same risk factors covered under the final rule (Exs. 26–521, 26–1421, 26–1008, 26–883, 26–500–71–92). Also, studies using specific interventions to reduce biomechanical load address these same risk factors (see section VI, Risk Assessment).

B. Overview of Evidence of Health Effects for Work-Related Musculoskeletal Disorders

A substantial body of scientific evidence supports OSHA's effort to provide workers with ergonomic protection (see the Health Effects Appendix of the proposal preamble, and the Health Effects Summary, Risk Assessment, and Significance of Risk sections of this preamble, below). This evidence strongly supports two basic conclusions: (1) there is a positive relationship between exposure to biomechanical risk factors and development of work-related musculoskeletal disorders and (2) ergonomics programs and specific ergonomic interventions can reduce these risks. Although it is recognized that many individual and non-biomechanical workplace factors (such as psychosocial factors) also contribute to the total risk, exposure to biomechanical factors has been shown to contribute to the risk independently from other causal factors; these findings support the appropriateness of designing interventions that reduce exposures to biomechanical factors as a strategy for reducing risk of MSDs.

This section presents an overview of the health evidence summarized from the proposal (64 FR 65865–65926; Ex. 27–1), updates that evidence with more recent information brought to the Agency's attention during the rulemaking process, and presents some additional information and conclusions as to the adequacy and quality of the overall scientific data base used for the final rule. In developing its review of the scientific evidence, the Agency has relied on almost 200 epidemiological studies that describe the prevalence or incidence of MSDs among workers who have been exposed to biomechanical risk factors. Several of these (see Part G of the Health Effects sections) simultaneously evaluated the effects of biomechanical and psychosocial factors in the workplace; these studies generally represent the most recent and best-designed epidemiological studies.

In addition to epidemiological studies, OSHA has reviewed a considerable amount of information and studies that describe the biomechanical aspects of MSD etiology, along with studies that have been conducted to elucidate the physiological responses of tissues to biomechanical stress. Much of this information was presented in detail in OSHA's Health Effects Appendices (Ex. 26–1), prepared at the time of the final rule. OSHA has since supplemented this information with additional material contained in the rulemaking record.

In compiling and evaluating the scientific evidence for its proposed ergonomic program standard OSHA made use of the two major reviews of the evidence for work-relatedness of MSDs available at that time, NIOSH's ''Musculoskeletal Disorders and Workplace Factors: A Critical Review of the Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back'' (Bernard, 1997; Ex. 26–1) and the National Research Council/National Academy of Sciences' ''Workshop on Work-Related Musculoskeletal Injuries: The Research Base'' (Ex. 26–37). Because OSHA's reliance on these two important works generated a considerable amount of comment and testimony, these two reviews are described in detail here. However, throughout this Health Effects section, OSHA has made use of several other scientific reviews of the literature as well.

The National Institute for Occupational Safety and Health (NIOSH) conducted a scientific review of hundreds of peer-reviewed studies, and evaluated the evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back (Bernard, 1997; Ex.26–1). The focus of this review was the epidemiology literature, the goal of which is to identify factors that are associated (positively or negatively) with the development of recurrence of adverse medical conditions. This evaluation and summary of the epidemiologic evidence focuses chiefly on disorders that affect the neck and the upper extremity, including tension neck syndrome, shoulder tendinitis, epicondylitis, carpal tunnel syndrome, and hand-arm vibration syndrome, which have been the most extensive studies in the epidemiologic literature. The document also reviews studies that have dealt with work-related back pain and that address the way work organization and psychosocial factors influence the relationship between exposure to physical factors and work-related MSDs. The literature about disorders of the lower extremity is outside the scope of the NIOSH review, and OSHA has done its own analysis of that literature. The NIOSH work is the most comprehensive review of this scientific literature to date.

A search strategy of bibliographic databases identified more than 2,000 studies. Studies were included if they evaluated exposure so that some inference could be drawn regarding repetition, force, extreme joint posture, static loading or vibration, and lifting tasks. Studies in which exposure was measured or observed and recorded for the body part of concern were considered superior to studies that used self-reports or occupational/job titles as surrogates for exposure.

Because of the focus on the epidemiology literature, studies that were laboratory-based or that focused on MSDs from a biomedical standpoint, dealt with clinical treatment of MSDs, or had other nonepidemiologic orientation were eliminated from further consideration for this document. This strategy yielded over 600 studies for inclusion in the detailed review process. Population-based studies of MSDs, case-control studies, cross-sectional studies, longitudinal cohort studies, and case series were included.

The first step in the analytical process was to classify the epidemiologic studies by the following criteria:

• The participation rate was ≥ 70%. This criterion limits the degree of selection bias in the study.
• The health outcome was defined by symptoms and physical examination. This criterion reflects the preference of most reviewers to have health outcomes that are defined by objective criteria.
• The investigators were blinded to health or exposure status when assessing health or exposure status. This criterion limits

observed bias in classifying exposure or disease.

- The joint (part of body) under discussion was subjected to an independent exposure assessment, with characterization of the independent variable of interest (such as repetition or repetitive work). Studies that used either direct observation or actual measurements of exposure were considered to have a more accurate exposure classification scheme, whereas studies that exclusively used job title, interviews, or questionnaire information were assumed to have less accurate exposure information.

During review of the studies, the greatest qualitative weight was given to studies that had objective exposure assessments, high participation rates, physical examinations, and blinded assessment of health and exposure status.

The second step of the analytical process was to divide the studies into those with statistically significant associations between exposures and health outcomes and those without statistically significant associations. The associations were then examined to determine whether they were likely to be substantially influenced by confounding or other selection bias (such as survivor bias or other epidemiologic pitfalls that might have a major influence on the interpretation of the findings). These include the absence of nonrespondent bias and comparability of study and comparison groups.

The third step of the analytical process was to review and summarize studies with regard to the epidemiologic criteria for causality: strength of association, consistency in association, temporal association, and exposure-response relationship. No single epidemiologic study will fulfill all criteria to answer the question of causality. However, results from epidemiologic studies can contribute to the evidence of causality in the relationship between workplace risk factors and MSDs. The exposures examined for the neck and upper extremity were repetition, force, extreme posture, and segmental vibration.

Using the epidemiologic criteria for causality as the framework, the evidence for a relationship between workplace factors and the development of MSDs from epidemiologic studies is classified into one of the following categories: strong evidence of work-relatedness, evidence of work-relatedness, insufficient evidence of work-relatedness, evidence of no effect of work factors. The amount and type of evidence required for each category is described below:

Strong evidence of work-relatedness. A causal relationship is known to be very likely between intense or long-duration exposure to the specific risk factor(s) and MSD when the epidemiologic criteria of causality are used. A positive relationship has been observed between exposure to the specific risk factor and MSD in studies in which chance, bias, and confounding factors could be ruled out with reasonable confidence in at least several studies.

Evidence of work-relatedness. Some convincing epidemiologic evidence shows a causal relationship when the epidemiologic criteria of causality for intense or long-duration exposure to the specific risk factor(s) and MSD are used. A positive relationship has been observed between exposure to the specific risk factor and MSDs in studies in which chance, bias, and confounding factors are not the likely explanation.

Insufficient evidence of work-relatedness. The available studies are of insufficient number, quality, consistence, or statistical power to permit a conclusion regarding the presence or absence of a causal association. Some studies suggest a relationship to specific risk factors, but chance, bias, or confounding may explain the association.

Evidence of no effect of work factors. Adequate studies consistently show that the specific workplace risk factor(s) is not related to development of MSD.

The above framework provides an indication of the selection criteria NIOSH used in identifying studies for inclusion in their review. Studies were included if the exposed and referent populations were well defined, and if they involved neck, upper-extremity, and low-back MSDs measured by well-defined, explicit criteria determined before the study. Studies whose primary outcomes were clinically relevant diagnostic entities, generally had less misclassification and were likely to involve more severe cases. Studies whose primary outcomes were the reporting of symptoms generally had more misclassification of health status and a wider spectrum of severity.

Care should be taken when interpreting some study results regarding individual workplace factors of repetition, force, extreme or static postures, and vibration. As Kilbom (1994; Ex. 26–1352) stated, these factors occur simultaneously or during alternating tasks within the same work, and their effects concur and interact. A single odds ratio (OR) for an individual risk factor may not accurately reflect the actual association, as not all of the studies derive ORs for simultaneously occurring factors. Thus these studies were not only viewed individually (taking into account good epidemiologic principles) but together for making broader interpretations about epidemiologic causality. Many investigators did not examine each risk factor separately but selected study and comparison groups based on combinations of risk factors (such as workers in jobs involving high force and repetition compared with workers having no exposure to high force and repetition.)

Based on the epidemiologic criteria described above, NIOSH made the following findings:

Strong evidence of work-relatedness exists for the following associations:

- High levels of static contraction, prolonged static loads, extreme working postures involving the neck/shoulder muscles and an increased risk for neck/shoulder MSDs;
- Exposure to a combination of risk factors (*e.g.,* force and repetition, force and posture) and CTS;
- Job tasks that require a combination of risk factors (*e.g.,* highly repetitious, forceful hand/wrist exertions) and hand/wrist tendinitis;
- High level exposure to hand-arm vibration and vascular symptoms of hand-arm vibration syndrome;
- Work-related lifting and forceful movements;
- Exposure to whole-body vibration and low-back disorder.

2. *Evidence* exists for the following associations:

- Highly repetitive work and neck and neck/shoulder MSDs, considering both repetitive neck movements (using frequency and duration of movements) and repetitive work involving continuous arm or hand movements;
- Forceful exertion and neck MSDs, with ''forceful work'' involving forceful arm or hand movements, which generate loads to the neck/shoulder area;
- Highly repetitive work and shoulder MSDs;
- Repeated or sustained shoulder postures with greater than 60 degree of flexion or abduction and shoulder MSDs;
- Highly repetitive work, both alone and in combination with other factors and carpal tunnel syndrome;
- Work involving hand/wrist vibration and CTS;
- Any single factor (repetition, force and posture) and hand/wrist tendinitis;
- Work-related awkward postures and low-back disorders.

3. *Insufficient evidence* of work-relatedness exists for the following associations:

- Vibration and neck disorders;
- Force and shoulder MSDs;
- Extreme posture and CTS.

The NIOSH review (Bernard, 1997; Ex. 26–1) is an authoritative, systematic, critical review of the epidemiologic evidence regarding work-related risk factors and their relationship to MSDs of the neck, shoulder, elbow, hand/wrist, and low back. In considering its purpose, the authors state:

This review of the epidemiologic literature may assist national and international authorities, academics, and policy makers in assessing risk and formulating decisions about future research or necessary preventive measures.

In 1998, the National Institutes of Health asked the National Academy of Sciences/National Research Council (NRC) to assemble a group of experts to examine the scientific literature relevant to the work-related musculoskeletal disorders of the lower back, neck and upper extremities. A steering committee was convened to design a workshop, to identify leading researchers on the topic to participate, and to prepare a report based on the workshop discussions and their own expertise. Additionally, the steering committee was asked to address, to the extent possible, a set of seven questions posed by Congress on the topic of musculoskeletal disorders. The steering committee includes experts in orthopedic surgery, occupational medicine, epidemiology, ergonomics, human factors, statistics, and risk analysis (NRC, 1999; Ex. 26–37). Note: The steering committee's report was published in 1998, and was referred to in OSHA's proposal as Ex. 26–37. In the final rule, Ex. 26–37 refers to the final report, (Work-Related Musculoskeletal Disorders: Report, Workshop Summary, and Workshop Papers, National Research Council, 1999; Ex. 26–37), which includes the steering committee's report, a summary of the proceedings of the 2-day workshop (Work-Related Musculoskeletal Injuries: The Research Base), and the workshop papers.

The charge to the steering committee, reflected in the focus of the workshop, was to examine the current state of the scientific research base relevant to the problem of work-related musculoskeletal disorders, including factors that can contribute to such disorders, and strategies for intervention to ameliorate or prevent them. The NAS/NRC organized their examination of the evidence of factors that potentially contribute to musculoskeletal disorders:

(1) Biological responses of tissues to biomechanical stressors;

(2) Biomechanics of work stressors, considering both work and individual factors, as well as internal loads;

(3) Epidemiologic perspectives on the contribution of physical (biomechanical) factors;

(4) Non-biomechanical (*e.g.,* psychological, organizational, social) factors; and

(5) Interventions to prevent or mitigate musculoskeletal disorders.

For four of these topics, discussions at the workshop centered on a paper (or papers) commissioned for the workshop, followed by the comments of invited discussants. For the epidemiology of physical factors, the steering committee used a panel format to take advantage of a recent review of this literature, the NIOSH review, published in 1997, and previously discussed here.

Use of this broad approach provided for the examination of evidence from both basic and applied science and a wide variety of methodologies, and considered sources of evidence that extend well beyond the epidemiologic literature alone. In determining whether scientific evidence supports a causal claim for risk factors and work-related musculoskeletal disorders, the NAS/NRC steering committee considered the following five criteria:

• *Temporal ordering* requires that the cause be present before the effect is observed.

• *Cause and effect covary.* For example, when no force is applied to a tendon, it remains in a relaxed state; in the presence of the cause (a force), the tendon responds.

• *Absence of other plausible explanations for the observed effect.* Adequate controlling of confounding factors by the design of the experiment or observation makes other explanations for the observed effect less likely.

• *Temporal contiguity,* amplifies the first (temporal ordering). To the extent that the effect follows the cause closely in time, the plausibility that other factors are operative is reduced.

• *Congruity between the cause and effect,* that is the size of the cause is related to the size or magnitude of the effect.

In its report, the NRC noted that in addressing complex research questions, such as relationships between risk factors and work-related musculoskeletal disorders, single studies rarely, if ever, provide conclusiveness of a causal relationship. Replication and synthesis of evidence across studies, preferably with studies that use a variety of methods (each with different strengths and weaknesses) strengthens causal associations. In performing such synthesis, studies that most completely satisfy the five criteria specified above should be given greatest weight. Inferential strength is gained by examining the evidence from a variety of theoretical perspectives, as well as a variety of research methods. A major strength of the NRC/NAS review is that it takes this broad approach toward evaluating the relevant scientific evidence.

In evaluating the epidemiologic literature and NIOSH's review of that literature, the NRC/NAS steering committee identified the following limitations in the epidemiologic evidence:

• Temporal contiguity between the stressors and onset of effects, as well as amelioration after reduction of stressors, could not always be established, nor could the clinical course of the observed effects;

• Methods used for the assessment of exposures and health outcomes vary, rendering the task or merging and combining evidence more challenging than in some other areas of occupational risk assessment;

• Lack of baseline prevalence and incidence data for the general population.

Despite these limitations, the steering committee reached the following conclusions regarding the epidemiologic evidence:

• Restricting our focus to those studies involving the highest levels of exposure to biomechanical stressor of the upper extremity, neck, and back and those with the sharpest contrast in exposure among the study groups, the positive relationship between the occurrence of musculoskeletal disorders and the conduct of work is clear. * * * (T)hose associations identified by the NIOSH review (NIOSH, 1997; Ex 26–1) as having strong evidence are well supported by competent research on heavily exposed populations.

• There is compelling evidence from numerous studies that as the amount of biomechanical stress is reduced, the prevalence of musculoskeletal disorders at the affected body region is likewise reduced. This evidence provides further support for the relationship between these work activities and the occurrence of musculoskeletal disorders.

• Evidence of a role for biomechanical stress in the occurrence of musculoskeletal disorders among populations exposed to low levels of biomechanical stressors remains less definitive, though there are some high-quality studies suggesting causal associations that should serve as the basis for further investigation. In cases of low levels of biomechanical stress, the possible contribution of other factors to musculoskeletal disorders is important to consider. The report then addresses other factors, including individual factors (*e.g.,* age, prior medical conditions); and organizational and social factors (*e.g.,* job content and demands, job control and social support).

The conclusions from the NAS/NRC report (Ex. 26–37) from the biomechanical literature are presented (in brief) in the previous discussion of ''force''in Section A.

In setting forth its conclusions on musculoskeletal disorders in the workplace, NRC/NAS steering committee notes that it has:

supplemented our professional expertise with workshop presentations, commissioned papers and other submissions, and discussions with invited workshop participants.

and, as a result concluded (in summary):

- There is a higher incidence of reported pain, injury, loss of work, and disability among individuals who are employed in occupations where there is a high level of exposure to physical loading than for those employed in occupations with lower levels of exposure.
- There is a strong biological plausibility on the relationship between the incidence of musculoskeletal disorders and the causative exposure factors in high-exposure occupational settings.
- Research clearly demonstrates that specific interventions can reduce the reported rate of musculoskeletal disorders for workers who perform high-risk tasks.
- Research can (1) provide a better understanding of the mechanisms that underlie the established relationships between causal factors and outcomes; (2) consider the influence of multiple factors (mechanical, work, social, etc.) on symptoms, injury, reporting, and disability; (3) provide more information about the relationship between incremental change in load and incremental biological response as a basis for defining the most efficient interventions; (4) improve the caliber of measurements for risk factors, outcome variables, and injury data collection systems; and (5) provide better understanding of the clinical course of these disorders.

The relevant scientific literature has been thoroughly and systematically evaluated by two highly-reputable and independent scientific bodies and their experts, who used different approaches to evaluate the literature from different scientific disciplines (while allowing for some overlap), using causality criteria from two related but different frameworks. The NIOSH and NRC/NAS reviews offer two distinct but consistent sets of conclusions that can be drawn from the literature on work-related musculoskeletal disorders. Generally, both reviews agree that the scientific evidence provides compelling support for a higher risk of work-related musculoskeletal disorders and the loss of work, and disability among individuals who are employed in occupations where there is a high level of exposure to physical loading (biomechanical factors), and that evidence clearly demonstrates that specific interventions can reduce the reported rate of musculoskeletal disorders for workers who perform high-risk tasks.

In the face of overwhelming evidence that biomechanical/physical risk factors in the workplace cause MSDs, some critics, such as UPS argue that there is not even *one* study which demonstrates that repetitive motion causes injury (Ex. 32–241–4). When asked at the hearing whether he agreed with this UPS position, Dr. Robert McCunney, representing the American College of Occupational and Environmental Medicine replied ''I find this statement incredulous'' (Tr. 7662). Dr. McCunney then continued in his testimony to state that there is sufficient scientific literature showing that repetitive motion activities can lead to MSDs. According to Dr. Barbara Silverstein, of the Washington State Department of Labor and Industries, scientific researchers who hold to the UPS view that there is no evidence that repetitive movements causes injury ''are in a minority'' (Tr. 17415). Likewise, in response to the same question regarding the UPS contention, Dr. Thomas Armstrong (University of Michigan) defended the scientific evidence that repetitive movements can result in injury, by replying:

> There are physiological studies looking at repetitive work as it contributes to muscle fatigue and changes in histology of muscle tissue. There are epidemiological studies that have looked at the relationship between various exposures to repetition and a variety of musculoskeletal types of disorders. These studies from different disciplines all come together and support the same conclusion.

Professional and scientific organizations supporting OSHA's determinations regarding the scientific basis underlying the standard include:

- American Association of Occupational Health Nurses (Ex. 30–2387)
- American College of Occupational and Environmental Medicine (Ex. 30–4468, Tr. 7637–7690)
- American Conference of Governmental Industrial Hygienists (Ex. DC–386, Tr. 16291–335)
- American Industrial Hygiene Association (Ex. 32–133–1, Tr. 16464–72, Tr. 16518–27)
- American Nurses Association (Ex. 30–3686, Tr. 15875–95)
- American Occupational Therapy Association (Ex. 30–4777, Tr. 18095–18121)
- American Public Health Association (Ex. 30–626, Tr. 17649–17704)
- American Society of Safety Engineers (Ex. 32–21–1–2; Tr. 11612)
- Human Factors and Ergonomics Society (Ex. 502–472)
- National Association of Orthopedic Nurses (Tr. 10578–10588)
- The American Society of Plastic and Reconstructive Surgery (Ex. DC–46, Tr. 1534)

OSHA finds no merit to assertions that there is insufficient science on which to base its proposal and subsequent final rule. Rather, the Agency finds that the body of scientific evidence on which OSHA based this rule is vast and conclusive. This position was supported by many witnesses and multiple pages of hearing testimony, and added to the substantial base of scientific literature that OSHA relied on for the publication of it's proposal. And, although there have been critics to OSHA's actions, they are in fact, in the vast minority. The science overwhelmingly supports reducing biomechanical risk factors in the workplace as an effective approach to reducing work-related musculoskeletal disorders.

When asked ''whether ACOEM believes that detection and elimination of these ergonomic risk factors at work can result in a reduction in the number of these disorders'' during the hearing, Dr. McCunney replied ''Very much so'' (Tr. 7663).

The following parts of this section discuss the evidence for the work-relatedness of MSDs. Tables V–1 through V–8 summarize some key aspects of the epidemiological studies that investigate MSDs, such as the occupations examined, the biomechanical risk factors they were exposed to, whether exposures were directly observed or measured during the study, and whether the health outcomes were verified by trained medical personnel during physical examination. The last column provides a quantitative (if available) risk measure or range of risk measures reported in each study that best captures the strength of the association between the studied biomechanical risk factor(s) and health outcome. Study entries with a single odds (or prevalence) ratio examined the relative risk between an exposed group of workers and unexposed referent population. For most studies, the risk values and confidence intervals were obtained from tables found in the 1997 NIOSH review (Ex. 26–1). For the additional studies not reviewed by NIOSH, OSHA obtained risk values from the material submitted in the docket.

Many studies reported risk ratios for multiple exposed groups and/or several indicators of exposure to biomechanical risk factors. In these cases, the range of reported risk measures were provided in the summary tables. OSHA did not include in this range; (1) risks ratios (high or low) that were inherently unstable because they were based on very low numbers of cases; (2) risk ratios that did not reflect differences in biomechanical risk factors; and (3) risk ratios in which the variation in exposure between groups were so small that a difference in MSD prevalence would have been difficult to detect. The 95 percent confidence interval for the upper end of the risk range were also recorded on the tables.

Some studies on the tables did not report odds (or prevalence) ratios, even though they may have established a statistically significant association between biomechanical risk factor and health outcome. Often, the association was expressed as a regression analysis between a particular biomechanical measurement and number of MSD cases. Sometimes, the study did not provide a risk measure but simply reported the MSD prevalence of different groups of exposed workers. These study entries were designated with a NR (risk ratio not reported).

C. Disorders of the Neck and Shoulder

MSDs of the neck and shoulder that have been documented in the scientific literature include the clinically well-defined disorders, such as tendinitis, and the less clinically well-defined soft tissues disorders, such as tension-neck syndrome (Gerr 1991, Ex. 26–1208; Moore 1992, Ex. 26–984). MSDs of the neck and shoulder often involve tendons, muscles, and bursa; nerves and blood vessels may also be affected. Because of the simultaneous involvement of several regional structures in neck and shoulder MSDs, there may be positive signs and/or symptoms in more than one structure. For example, strong abduction or extension of the upper arm, as well as awkward postures of the neck, can compress parts of the brachioplexus under the scalene muscles and other anatomical structures. This compression can result in nerve and/or blood vessel damage or in eventual damage to the tissues served by these nerves and vessels.

Neck and Upper Back

In this section, OSHA summarizes the evidence for an increased risk for musculoskeletal disorders of the neck and upper back associated with exposure to biomechanical risk factors in the workplace. This region (neck and upper back) includes the cervical and thoracic spine (spine above the lumbar or low back) and supporting structures and tissues. The scientific literature frequently refers to this region as ''Neck and Neck/Shoulder,'' or as ''Neck and Shoulder'' or as ''Neck and Upper Back.'' With respect to the epidemiologic literature, the studies NIOSH referred to in it's ''Neck and Neck/Shoulder'' section are included in this section. A summary of the evidence regarding the shoulder only is reviewed in the separate section following this one. For greater detail on the scientific evidence summarized here see 64 FR 65865–65926).

The lifetime prevalence of neck pain is estimated at 40% to 50%, with a 1-year prevalence of about 20% (Takala *et al.*1982, Ex. 26–1169). Using a definition of 2 weeks of neck pain, the prevalence among men and women aged 25 to 74 years in the NHANES Survey II (1976 to 1980) was 8.2% (Praemer, Furner, and Rice 1992, Ex. 26–869). Chronic neck pain is estimated to be present in up to 9% to 10% of males and 12% to 14% of females (Makela *et al.*1991, Ex. 26–980; Revel *et al.*1994, Ex. 26–195). Individuals in the 4th to 6th decades of life have the greatest incidence of neck disorders (Makela *et al.*1991, Ex. 26–980; Praemer, Furner, and Rice 1992, Ex. 26–869).

What is known about the course of neck pain? It is estimated that 90% of patients with acute neck pain are improved within 2 months (Borenstein, Wiesel, and Boden 1996, Ex. 26–1394). The Quebec Spinal Study (1987, Ex. 26–494) series of individuals with work-related spinal disorders suggests that 74% recover by 7 weeks. A 10-year outcome study of patients with neck pain revealed that 79% had less pain and 43% were pain-free. However, 32% still experienced moderate or severe pain (Gore *et al.*1987, Ex. 26–127). With regard to work-related MSDs, some intervention studies have suggested that workplace modifications may decrease both symptoms of neck pain and/or muscle activity as recorded by EMG (Aaras 1994a, Ex. 26–892; Aaras *et al.*1998, Ex. 26–597; Schuldt *et al.*1987, Ex. 26–670).

The extent to which neck pain occurs in or affects workers depends to a great extent on the terms used to define the pain, in terms of intensity and duration, and on the methods used in determining the presence or occurrence (self-report, interview, or physical examination). Point prevalence of neck pain in a general U.S. population has been reported at 10%, matching point prevalence reports of workers in an aeroengineering factory and exceeding a 4% prevalence reported in a group of textile workers (Palmer *et al.*1998, Ex. 26–1529). Other estimates found in the literature include 68% for female and 47% for male Swedish industrial workers performing unskilled tasks (3-month prevalence of MSDs in the neck and in the thoracic back)(Bjorksten *et al.*1996, Ex. 26–604). One-year prevalence of neck pain or neck and upper-back pain was 16% in a group of electricians, excluding neck pain associated with traumatic injury, and 38% with a less restrictive definition (Hunting, *et al.*199, Ex. 26–1273); 26% and 18%, in the Danish wood and furniture industry respectively (Christensen, Pedersen, and Sjogaard 1995, Ex. 26–95). Prevalence of regular discomfort in the posterior neck region was 6.3%, and 9.1% in the upper-back region, in a group of chicken-processing workers. However, the lifetime prevalence was 36%, the point prevalence was 18%, and 9% had sought medical treatment for discomfort (Buckle 1987, Ex. 26–938).

Many studies of neck pain have focused on employees working in health care. Milerad and Ekenvall (1990, Ex. 26–1291) reported cervical symptom prevalence of 45% of male dentists and 63% of female dentists, rates that were 2.6 and 2 times those of male and female pharmacists, respectively. Twelve-month prevalence of self-reported neck pain was 63.1% in a group of medical secretaries and hospital office personnel (Linton and Kamwendo 1989, Ex. 26–978).

With regard to work-related cervical spine disorders, the Quebec Spinal Study (1987, Ex. 26–494) observed an annual incidence of over 0.1%. However, Bjorksten *et al.*(1996, Ex. 26–604) reported a 68%, 3-month prevalence for neck pain in industrial workers performing unskilled tasks, more than double the rate in the general population. Certain jobs appear to have greater associations with neck pain than others, with the lifetime prevalence of neck and shoulder symptoms reaching 81% in machine operators, 73% in carpenters, and 57% in office workers (Tola *et al.*1988, Ex. 26–1018). It must be understood that there may be an underestimation of work-relatedness of neck pain since the onset of pain may, at times, be delayed and the work relation uncertain.

Tension neck syndrome is a myofascial (muscle pain) localized in the shoulder and neck region (Hagberg 1984; Ex. 26–1271). Also called scapulocostal syndrome (Fine and Silverstein 1998; Ex. 38–444), these syndromes are often characterized by diffuse tenderness over the muscle, rather than the tendon origin, and activity limitation. The pathophysiology is unknown; however, a number of mechanism have been proposed, including inflammation. Two types of muscle activity may be important in work-related disorders: low-force, prolonged muscle contractions (*e.g.,* in office workers moderate neck flexion while working on a visual display terminal (VDT) for many hours without rest breaks); and infrequent or frequent high-force muscle contractions (intermittent use of heavy tools) in overhead work). Sustained static contractions can lead to increases in intramuscular pressure, which in turn may impair blood flow to cells within the muscle (Hagberg, 1984; Ex. 26–1271).

Motor nerve control of the working muscle may be important in sustained static contractions since even if the relative load on the muscle as a whole is low, the active part of the muscle may be working close to it's maximal capacity. Thus, small areas of large muscles such as the trapezius may have disturbances in microcirculation that might contribute or cause the development of muscle damage (red ragged fibers), reduce strength, higher levels of fatigue, sensitization of pain receptors in the muscle, and pain at rest (Armstrong, Buckle and Fine 1993, as cited in Fine and Silverstein 1998, Ex. 38–444). High levels of tension (strong contractions) can lead to muscle fiber Z-line rupture, muscle pain, and large, delayed increases in serum creatine kinase. These changes are reversible and can be completely repaired, often leading the muscle to be stronger. It is hypothesized that if damage occurs daily due to work activity, the muscle may not be able to repair the damage as fast as it occurs, leading to chronic muscle damage or dysfunction. The mechanism of this damage at the cellular level is not understood (Armstrong, Buckle and Fine, 1993 as cited in Fine and Silverstein 1998, Ex. 38–444).

Hagberg (1984, Ex. 26–1271; and Hagberg and Wegman 1987, as cited in Magnusson and Pope Ex. 38–450) described three possible pathophysiological mechanisms for occupational muscle-related disorders, such as tension neck syndrome. The first is mechanical failure, due to temporary high local stress involving eccentric contractions on the shoulders, such as in workers unaccustomed to the work task. The second is local decreased blood flow (ischemia), as seen in assembly workers whose tasks involved dynamic, frequent contractions above 10 to 20% of the maximum voluntary contraction and few rest breaks. Both a reduction in blood flow and pathologic changes were found to be correlated with myalgia (muscle pain) and ragged red fibers in 17 patients doing repetitive assembly work (Larsson *et al.*1990, Ex. 26–1141).

The third pathophysiologic mechanism for muscle pain (Hagberg 1984, Ex. 26–1271) energy metabolism disturbance, occurs when energy demand exceeds production. Long-term static contractions of the muscles result in the prolonged recruitment of limited numbers of motor units, and can deplete available energy, producing eventual fatigue and injury (Lieber and Friden 1994, Ex. 26–559). Higher subjective levels of fatigue as well as electrophysiological evidence of fatigue are more common in large muscle groups, such as the neck and shoulder muscles, when activities are static and repetitive rather than dynamic (Sjogaard 1988, Ex. 26–830).

Pain arising from cervical spine skeletal structures may potentially originate from many locations, since sensory nerve innervation is present in ligaments, joint capsules, the anterior and posterior longitudinal ligaments, the outer third of the annulus fibrosus, and the vertebral body (Bogduk 1982, Ex. 26–1479; Bogduk *et al.*1988, Ex. 26–514; Hirsch, Inglemark, and Miller 1963, Ex. 26–471). The periosteum of the cervical vertebral body may be a source of pain, although some slowly progressive lesions may destroy a significant amount of bony tissue before they are recognized (Borenstein, Wiesel, and Boden 1996, Ex. 26–1394). The spinal nerve roots are the source of pain when there is compression, ischemia, and inflammatory or chemical mediators that stimulate nociceptors.

Cervical spondylosis refers to degenerative changes in the cervical spine that are apparent on radiological examination (Hagberg and Wegman 1987, Ex. 26–32). The pathogenesis of cervical spine degenerative disease has similarities to many other joint structures, although there are important differences. The cervical spine has a great deal more movement, achieved via gliding and sliding on adjacent structures, than the remainder of the spine. And not being subject to repetitive and impulsive loading, cervical spinal segments do not require the strength and stability of the lumbar-sacral spine. However, these zygoapophyseal joints in the cervical spine have fibrocartilagenous, meniscus-like structures that are capable of responding with proliferative changes (Bland 1994, Ex. 26–416). As with other joints, aging, repetitive motion, and some loading result in fissuring of the hyaline cartilage surfaces. Gradually, the hyaline cartilage develops deeper and downward fissuring, larger erosions, and general thinning. In the cervical spine, the chondrocytes proliferate in areas of fibrillation or loosely textured matrix (Bland 1994, Ex. 26–416). And though the matrix may demonstrate some attempts at repair, the repair is generally disorderly. Subchondral bone increases in density, followed by microfracturing and callus formation. New bone, called osteophytes, appear at the margins of the articular cartilage, and may protrude into the joint space or neuroforamen. If large enough, this may cause nerve compression. Posterior spondylotic bars, especially if combined with hypertrophy of the ligamentum flavum, have the potential to compress the spinal cord, causing symptoms of cervical myelopathy. Anatomically, the C4 to C5, C5 to C6, and C6 to C7 intervertebral disc spaces are most commonly affected by osteoarthritis and degenerative disc disease.

Thoracic outlet syndrome (TOS) is defined as a ''neurovascular impingement syndrome at different anatomical levels where the brachial plexus and subclavian vessels may be entrapped as they pass through, en route from the cervical spine to the arm.'' (Hagberg *et al.*1995, Ex. 26–432). The syndrome involves compression of the subclavian artery and the lower trunk of the brachial plexus, at one or more locations between the neck and the axilla. Symptoms are experienced in the upper extremity. Cervical syndrome is defined as ''compressions of the nerve root by a herniated disc or a narrowed intervertebral foramen'' (Hagberg *et al.*1995, Ex. 26–432).

Epidemiological Evidence

Several muscles act upon the upper spine and shoulder girdle together; Scandanavian studies have often combined neck and shoulder MSDs. Neck pain and MSDs will be discussed here. Those studies that evaluated neck and shoulder pain and MSDs together will also be included. Studies that exclusively evaluate pain and MSDs of the shoulder will be discussed in a subsequent section. Studies that have evaluated objective findings and/or met diagnostic criteria for specific disorders have been given greater weight in this analysis.

There have been several reviews that associate neck disorders work factors, such as repetition, force, static loading, neck posture, and heavy work (NIOSH 1997, Ex. 26–1; Grieco, *et al.*1998, Ex. 26–627; Hagberg *et al.*1995, Ex. 26–432; Hales and Bernard 1996, Ex. 26–896; Viikari-Juntura 1997, Ex. 26–905; Hagberg and Wegman 1987, Ex. 26–32). The majority of neck disorders involve soft tissues (muscle and ligament strains and sprains). Outcomes studied and reported are often non-specific, for example, neck pain or/or stiffness. Some studies relied on combination of symptoms and physical exam confirming tenderness in neck muscles and tendons upon palpation and/or localized pain during neck movement. Many others simply relied on self-reported symptoms on a questionnaire. While duration of symptoms and case definitions were not always completely consistent, all studies attempted to exclude pain and/or discomfort that was transient or less than significant intensity.

In a few epidemiological studies, objective exposure measurement that pertained to the neck region, such as work load assessments, electromyography, neck angle measurement, was obtained. However in most studies, exposure assessments were based on job titles or self-reports. In some investigations the primary interest and measurement strategy was focused on hand/wrist region, even though neck disorders were studied as one of the outcomes. Hand/wrist exposures will not necessarily reflect the biomechanical status of the neck, and, therefore these studies have potential for considerable exposure misclassification are given less weight.

Bernard (1997, Ex. 26–1) and NIOSH reviewed epidemiological studies for evidence of work-relatedness of neck and neck/shoulder musculoskeletal disorders. In the process of identifying papers for this review, Bernard (1997, Ex. 26–1) first considered the strength of each study based on whether it provided clear definitions of exposed and reference populations and clear definitions of outcomes, as well whether it evaluated exposures in such a way as to classify them with regard to force, repetition, posture, or vibration. Papers that met these standards were then evaluated based on four criteria: a 70% or better response rate in order to limit response bias, health outcome defined by symptoms and physical examination (PE)(1), investigators blinded where appropriate (exposure or health status), and the neck as a focus of the evaluation. Only one of the studies that focused on the neck and two that focused on the neck/shoulder region met all four criteria. The likelihood of bias in each study was examined. Finally, studies were summarized with respect to strength of association, demonstration of temporal association, consistency of association among studies, and exposure-response relationship.

The NIOSH review identified 46 epidemiological studies (1976 to 1995) reporting on the neck and 23 reporting on the neck/shoulder region. Of these studies, 38 were cross-sectional, 2 were case-control, and 6 were prospective studies. Table V–1 summarizes some key aspects of these investigations, such as the occupations examined, the biomechanical risk factors the workers were exposed to, whether exposures were directly observed or measured during the study, and whether the health outcomes were verified by trained medical personnel during physical examination. Thirteen of the studies directly measured or observed a combination of repeated arm/shoulder movements, strenuous work that generates loads to the neck/shoulder muscles, and extreme static postures. The eleven studies also used physical examination by a health professional to define workers with neck disorders. OSHA regards these investigations as more reliable than those in which direct exposure was not observed or in which neck injuries are self-reported. Twelve of the thirteen studies reported a statistically significant association between these disorders and physical work factors (force, repetitive motion, awkward posture).

TABLE V–1.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING NECK AND UPPER BACK MUSCULOSKELETAL DISORDERS

Study	Job type studies	Physical factors	Exposure basis	Diagnosis	Risk Measure (95% CI) [1]
Hunting (1981) Ex. 26–1276	VDT operation	R/P	observation body posture	physical exam	OR=9.9 * (3.7–26.9)
Veiersted (1994) Ex. 26–1366	chocolate manufacture.	F/R?/P	EMG	physical exam	OR=6.7–7.2 * (2.1–25.3)
Ohlsson (1995) Ex. 26–868	assembly line	R/P	neck flexion cycle time	physical exam	OR=3.6 * (1.5–8.8)
Bergqvist (1995) Ex. 26–1195	VDT operators	R/P	observation	physical exam	OR=3.6–4.4 * (1.1–17.6)
Bergvist (1995) Ex. 26–1196	VDT operators	R/P	observation	physical exam	OR=6.9 * (1.1–42.1)
Onishi (1976) Ex. 26–1222	film rolling	F?/R/P	observation EMG	physical exam	OR=3.8 * (2.1–6.6)
Norander (1999) Ex. 38–408	fish processing	R/P	observation cycle time	physical exam	OR=3.0 * (1.5–5.9)
Kukkonen (1983) Ex. 26–1138	data entry	R?/P	posture observation	physical exam	OR=2.3 * (1.1–4.6)
Bjelle (1981) Ex. 26–1519	industrial plant	F/R/P	flexion EMG	physical exam	NR *
Jonsson (1988) Ex. 26–969; Kilbom (1986) Ex. 500–41–75.	electronics manufacture.	F/R/P	flexor MVC flexion	physical exam	NR *
Dimberg (1989) Ex. 26–1211	automotive	F/R/P	observation	physical exam	NR* (p<0.1)
Sakakibara (1995) Ex. 26–800	fruit bagging	F?/R?/P	observation arm elevation	physical exam	OR=1.5 (1.0–2.3)
Rosecrance (1994) Ex. 38–203	newspaper work	F?/P/R	questionnaire	symptoms only	OR=29 *
Andersen (1993) Ex. 26–1502	sewing machine	F/R/P?	job titles	physical exam	OR=6.8 * (1.6–28.5)
Baron (1991) Ex. 26–697	grocery checking	F/R/P	job titles	physical exam	OR=2.0 (0.6–2.7)
Bernard (1994) Ex. 26–842	newspaper publishing.	R?/P	observation	symptoms only	OR=1.4 * (1.0–1.8)
Blader (1991) Ex. 26–1215	sewing machine	R/P	questionnaire	physical exam	NR *
Hales (1989) Ex. 2–3–pp	poultry processing.	F/R	job title	physical exam	OR=1.6 (0.4–3.2)
Hales (1994) Ex. 26–131	telecommunication.	R?/P	questionnaire	physical exam	OR=3.8* (1.5–9.4)

TABLE V–1.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING NECK AND UPPER BACK MUSCULOSKELETAL DISORDERS—Continued

Study	Job type studies	Physical factors	Exposure basis	Diagnosis	Risk Measure (95% CI) [1]
Hunting (1994) Ex. 26–1273	electrician	V/F/R/P	questionnaire	symptoms only	OR=1.6 (NR)
Kamwendo (1991) Ex. 26–1384	medical secretary	R/P	questionnaire	symptoms only	OR=1.6* (1.0–2.7)
Kiken (1990) Ex. 26–430	poultry processing.	F/R	job title	physical exam	OR=1.3 (0.2–11)
Knave (1985) Ex. 26–753	VDT operation	R/P	questionnaire	symptoms only	OR=1.6 (0.4–3.2)
Kuorinka (1979) Ex. 26–639	scissor production.	R/P	job title	physical exam	OR=4.1* (2.3–7.5)
Luopajarvi (1979) Ex. 26–56	food production	F/R/P?	job title	physical exam	OR=1.6 (0.9–2.7)
Schibye (1995) Ex. 26–1463	sewing machine	F?/R/P?	questionnaire	symptoms only	OR=3.3* (1.4–7.7)
Liss (1995) Ex. 26–55	dental hygienist	F/R/P?	questionnaire	symptoms only	OR=1.7* (1.1–2.6)
Ohlsson (1989) Ex. 26–1290	auto assembly	F/R/P?	job title	symptoms only	OR=1.9 (0.9–3.7)
Andersen (1993) Ex. 26–1451	sewing machine	F/R/P?	job titles	symptoms only	OR=3.2–4.9* (2.0–12.8)
Eckberg (1995) Ex. 26–1193	residents	F?/R/P?	questionnaire	symptoms only	OR=1.2* (1.0–1.3)
Eckberg (1994) Ex. 26–1238	case-control	F?/R/P	questionnaire	symptoms only	OR=3.6–15.6* (3.2–113)
Milerad (1990) Ex. 26–1291	dentist	R/P	questionnaire	symptoms only	OR=2.1* (1.2–3.1)
Punnett (1991) Ex. 26–39	meat processing	F/R/P?	observation	symptoms only	OR=0.9–1.8 (1.0–3.2)
Rossignol (1987) Ex. 26–804	computer operation.	R/P	questionnaire	symptoms only	OR=1.8–4.6* (1.7–13.2)
Viikari-Juntura (1994) Ex. 26–873	machine operation.	F/R?/P/V	observation	symptoms only	OR=3.0–4.2* (2.0–9.0)
Wells (1983) Ex. 26–729	letter carrier	F/R?/P	job title	symptoms only	OR=2.6* (1.1–6.2)
Aaras (1994) Ex. 26–892	telephone assembly.	F/R?/P	EMG muscle load	symptoms only	NR*
Ferguson (1976) Cited in Ex. 26–1	telephone interview.	R?/P	posture measures.	symptoms only	NR
Maeda (1982) Ex. 26–1224	machine operators.	F?/R?/P?	questionnaire	symptoms only	NR*
Linton (1989) Ex. 26–729	medical secretary	R?/P?	questionnaire	symptoms only	NR
Linton (1990) Ex. 26–977	multiple industries.	F?/R?/P	questionnaire	symptoms only	OR=3.5 (2.7–4.5)
Sakakibara (1987) Ex. 26–1199	fruit bagging	F?/R/P	neck/shoulder flexion.	symptoms only	OR=1.6 (0.4–3.2)
Welch (1995) Ex. 26–1268	sheet metal processing.	F?/R/P	questionnaire	symptoms only	OR=7.5 (0.8–68)
Yu (1996) Ex. 26–696	VDT operation	R?/P	questionnaire	symptoms only	OR=29 (2.8–291.8)
Holmstrom (1992) Ex. 26–36	construction	F?/R?/P	questionnaire	symptoms only	OR=2.0* (1.4–2.7)
Ryan (1998) Cited in Ex. 26–1	data processing	R?/P	shoulder flexion	symptoms only	NR*
Ohara (1976) Cited in Ex. 26–1	cash register	F?/R?/P?	job title	physical exam	NR
Tola (1988) Ex. 26–1018	machine operation.	F?/R?/P	job title	symptoms only	OR=1.8* (1.5–2.2)
Vihma (1982) Ex. 26–789	sewing machine	R/P	observation cycle time	symptoms only	PRR=1.6* (1.1–2.3)
Viikari-Juntura (2000) Ex. 500–41–50	forest industry	P/R?	questionnaire	symptoms only	OR=1.4
Botha (1998) Ex. 500–212–10	nurses	P/F	observation	symptoms only	NR*
Bjork Csten (1996) Ex. 26–604	metal working	R/P	questionnaire	symptoms only	NR
Ignatius (1993) Ex. 26–1389	typists	F/R?/P	questionnaire	symptoms only	OR=3.4*
Slov (1996) Ex. 26–674	sales	P	questionnaire	symptoms only	OR=2.8* (1.4–5.59)

F=forceful exertions; R=repetitive motion; P=awkward posture; ?=presence of risk factor unclear
OR=odds ratio; PRR=prevalence rate ratio, NR=not reported;
*=p<0.05
[1] 95% confidence interval expressed for the upper end of the risk measure range

The odds ratios determined from the studies ranged from 1.1 to 9.9. Several studies deserve special mention. Ohlsson *et al.*(1995, Ex. 26–868) compared 82 female industrial workers exposed to short-cycle tasks (less than 30 seconds) to 64 referents with no exposure to repetitive work. The OR for tension neck syndrome was 3.6 (95% CI: 1.5–8.8).

The NIOSH authors concluded that there was ''reasonable evidence'' for an association between highly repetitive work and neck/shoulder MSDs, where repetitiveness was most often defined in terms of hand activity. They also determined that there was ''reasonable evidence'' for an association between forceful exertion and neck/shoulder MSDs, where forceful work was conducted by the arms. They concluded there was ''strong evidence'' for an association between static loads and neck/shoulder MSDs, where ''static load'' referred to a static load of long duration, high intensity, or extreme amplitude. In many of the situations under study, workers were exposed to more than one of these physical risk factors during the course of their jobs. The NIOSH review found insufficient evidence of an association between vibration and neck disorders.

In an earlier review, Hales and Bernard (1996, Ex. 26–896) concluded that neck disorders were associated with work involving repetitive motions, forceful repetitive work, and constrained or static postures, based on consistency of association across several studies. They noted inconsistent findings regarding neck disorder and work pace, which, they suggested, may be due to the many ways work pace can be quantified. Hales and Bernard also mentioned a consistent association between wearing bifocals, awkward neck postures, and neck disorders.

Hagberg *et al.* (1995, Ex. 26–432) reviewed epidemiological studies for evidence of work-relatedness of selected musculoskeletal disorders of the neck: TOS (neurogenic form), cervical syndrome, and tension neck syndrome. In compiling a list of valid papers for their review, the researchers considered the strength of each study based on minimization of bias (selection bias, information or misclassification bias, confounding or effect modification bias) and study power. Studies that met their validity criteria were then reviewed for causality (strength of association, demonstration of temporal association, consistency of association among studies, predictive power of exposure factors, and plausibility.

Hagberg *et al.* found six cross-sectional studies of TOS (published between 1979 and 1991) that met their inclusion criteria. From those studies they found the strength of association between work and TOS to be generally weak, based on low odds ratios (ORs). Since all studies were cross-sectional in design, temporal associations could not be confirmed. There seemed to be a consistent association between repetitive work and TOS across the studies. One study demonstrated a dose-response relationship between vibration and TOS. The authors also noted an association between TOS and age. Hagberg *et al.* (1995, Ex. 26–432) concluded that the studies demonstrated the existence of a consistent association between repetitive arm movements, manual work, and TOS.

In their review, Hagberg *et al.*(1995, Ex. 26–432) found twelve cross-sectional studies and one laboratory study of tension neck syndrome (published between 1976 and 1988) that met their inclusion criteria. From those studies, Hagberg *et al.*(1995, Ex. 26–432) found the strength of association between work and tension neck syndrome to be moderate, based on ORs from 3 to 7. There seemed to be a consistent association between work with VDTs and tension neck syndrome across several studies, including a determination of an OR for tension neck syndrome of 2.0 in keyboard operators (Hagberg and Wegman 1987, Ex. 26–32). There also seemed to be consistent associations between tension neck syndrome and repetitive work and static head and arm postures. The authors also noted that tension neck syndrome was found more commonly in women, but that finding may have been confounded by differences in work. Hagberg *et al.*(1995, Ex. 26–432) concluded that the studies demonstrated the existence of a consistent association between repetitive work and tension neck syndrome caused by constrained head and arm postures. They also noted that tension neck syndrome had a high prevalence in both work and reference groups.

Three cross-sectional studies of cervical radiculopathy (published between 1979 and 1983) met the criteria of Hagberg *et al.*They observed that all studies showed a low prevalence for cervical radiculopathy. Low numbers meant wide confidence intervals, which made results difficult to interpret. They concluded that more directed research needed to be conducted in this area.

In a review of the epidemiological evidence for three neck-related MSDs, the contributors to Kourinka and Forcier (1995 Ex. 26–432) report consistent associations between exposures to static head and arm postures and outcomes of tension neck syndrome. They did not find convincing evidence of a connection between repetition and cervical radiculopathy.

A recent review of epidemiological studies by Grieco *et al.*(1998, Ex. 26–627) concluded that cervical radiculopathy had not been shown to be associated with data entry work, dockers' work, or food production assembly line work. In contrast, tension neck syndrome was linked to static postures and static loads in several studies on populations of VDT workers, typists, and sewing machine operators. Study selection criteria were not discussed in that review.

Several individual studies of workers performing heavy work (including meat carriers and miners) found increased ORs (most adjusted for age) for cervical spondylosis, as did one study of dentists. Viikari-Juntura (1997, Ex. 26–905) reviewed both epidemiological and experimental studies focused on the neck (among other regions). The author mentioned studies that showed associations between degenerative changes or neck pain and heavy work, repeated impact loading, or static work, whereas the OR for cervical spondylosis in cotton workers was 0.66 (protective). The relationships between work factors and cervical spine arthritis have not been clarified due to (1) few studies of this subject, (2) a lack of universal acceptance for the criteria (*e.g.,* symptoms, signs, imaging) used to make this diagnosis, and (3) cervical spine degenerative changes are common.

Four additional epidemiological studies that address physical work factors and neck and neck/shoulder disorders were submitted into the OSHA docket following publication of the proposal and have been added to Table V–1 (Nordander et. al. 1999, Ex. 38–408; Viikari-Juntura 2000, Ex. 500–41–50; Botha and Bridger 1998, Ex. 500–121–10; Rosecrance et al 1994, Ex. 38–203). OSHA found a few additional studies identified in the NIOSH epidemiological review for other MSDs that also addressed neck and neck/shoulder and are also included in Table V–1 (Dimberg 1989, Ex. 26–1211; Ignatious 1993, Ex. 26–1389; Skov 1996, Ex. 26–674). Two other submitted studies contained some serious methodological flaws and were not included in the table (Leclerc *et al.,* 1999, 500–118–2; Erikson *et al.,* 1999, 500–118–2).

Nordander *et al.*1999 (Ex. 38–408) reported on a cross sectional study of 13 fish processing plants, examining multiple body sites, including the neck and shoulder. Ninety one male and 165 female fish industry workers were compared to men and women with more varied work. The work was partly paid by the work done—piece work. Health outcome was based on questionnaire and physical examination. Exposure was assessed by questionnaire, videotaping of jobs, and the observational method using AET (Arbeitwissenschaftliche Erbehungverfahren zur Tatigkeitsanalyse) along with the NIOSH lifting equation. Each work task classified according to three factors: weight of the materials handled (<1, 1<5, 5<10, 10–25, >25 kg.), cycle time (<5, 5–10, 10–60, >60); and degree of constrained neck postures (low, high, very high). Neck and shoulder diagnoses among the fish processors was found to be significantly elevated compared to the referents (OR=3.5; 95% CI 2.3–5.3). There was significantly increased prevalence of shoulder tendinitis found among women fish processors (OR from 3.4 to 4.65) compared to referents. No significant effects were found due to age, leisure time and smoking assessed by logistic regression. Job analysis found that several tasks were repetitive, performed in constrained work postures, with fast and continuous wrist and hand movements, mostly with flexed neck, arms raised and lowered intermittently. Because it involved a direct assessment of exposure and verification of neck injury by a health professional, OSHA views the study to be among the more reliable investigations.

Viikari-Juntura *et al.*2000 (Ex. 502–11) recently published findings on a longitudinal study of neck pain among a cohort of 5180 workers in a large forest industry enterprise. Participation rate was only 43% of the originally selected cohort of 7000. Nonrespondents were also followed up—there was no difference with regard to potential predictors except reporting 1.5 times difficulties in coming 5 years due to musculoskeletal health. Four repeated questionnaires were used focusing on ''radiating neck pain,'' categorized as healthy (0–7 days), mild pain (8–30 days), and severe pain (>30 days). Validated exposure assessment questionnaires and psychosocial questionnaires were used. There were several variables related to physical strenuousness, awkward postures, repetitive movements, and stress. Results found a statistically significant dose-response relationship for neck pain and increasing number of hours working with the hands above the shoulder. The risk of neck pain also increased with increasing amounts of twisting movements, but for the combination of twisting of the trunk and stress, neck pain decreased with increasing amounts of stress.

Rosecrance (1994, Ex 38–457) conducted a cross-sectional study of 906 office and production workers from three medium sized newspaper facilities to determine the level of symptomatic workers and to compare the office and production workers. A participation rate of 72% was reported. A physical exam was given to 105 participants. Exposure was assessed by a self-reported job factor survey. The results found that workers who reported repetitive tasks had an odds ratio of 29 (CI not reported, p=0.01) of missing work due to neck symptoms compared to workers who did not report repetitive tasks. Production workers reported more job risk factors compared to office workers. Neck symptoms were the most common symptom among production workers.

Faucett and Rempel, 1994 (Ex 38–67) carried out a cross-sectional study of 150 video display terminal (VDT) operators from large metropolitan newspaper. Participation rate was low at 56%, however, non-respondents had no difference in age, duration of employment, gender, job title, or VDT training. A questionnaire-derived health outcome using a body diagram was employed. Observational exposure assessment was performed on 70 VDT workstations, completed by trained independent observers working in pairs evaluating work posture, wrist, knee and leg contact with workstation, display and seat height, angle measures of wrist, elbow, shoulder, head, trunk at the hip and thigh. Results found that 28% met symptom criteria for MSDs of the upper torso and extremities. Risk of having a MSD increased with a greater number of daily hours of VDT use. After controlling for the ergonomic factors, less decision latitude on the job and less coworker support were found to be significantly associated with certain symptoms (numbness). The limitations of this study are the low participation rate, although the non-responders were followed up and the non-specific nature of the health outcome.

Leclerc *et al.,* 1999 (Ex. 500–118–2) conducted a longitudinal study to evaluate the effects of prevention programs at the workplace aimed at reducing back, neck, and shoulder morbidity among active workers. The intervention group (294 workers) and the referent group (294 workers) were collapsed and analyzed as a whole. Health outcome was based on two questionnaires. Questions ''focused more on the potential risk factors for low back pain, such as bending forward and backward, twisting, and handling of materials.'' The authors note that ''the role of specific occupational risk factors of neck disorders, such as awkward postures of the head and neck and static postures, was not studied because these variables were not included in the questionnaire.'' Analyses were performed with ''occupation'' as a crude indicator of occupational exposure. Female gender, older age, headaches or pain in the head, psychological distress, and psychosomatic problems were predictors of neck pain. This study found that there was no significant difference in occurrence of neck pain among the different occupations—hospital workers, warehouse workers, and office workers. This is not surprising, as many studies have found increased rates of neck symptoms in these occupational groups. What is lacking in this study, as admitted by the authors, is adequate assessment of risk factors known to be associated with neck MSDs. The poor exposure assessment concerning occupational factors does not detract from the relationship of exposure to certain work factors and neck disorders. Because of its failure to address specific work factors related to neck disorders, OSHA does not regard this study as adequate and it was not included in Table V–1.

Eriksen *et al.,* 1999 (Ex. 500–118–2) carried out a community-based 4-year prospective study of 1429 working Norwegians who completed a questionnaire in 1990, and returned a second questionnaire 4 years later. The participation rate was 67% of original group in 1990; 79.8% of working group from 1990 responded to 2nd questionnaire in 1994. The health outcome was based on the Nordic questionnaire, ''presence of any neck pain during the previous 12 months.'' Workplace exposure also relied on questionnaire data. Questions concerned work with hands over shoulder-level, static work positions, repetitive stereotypic movements, heavy lifting, sitting, standing, and high work pace. The authors note that the responders in 1994 were ''less inclined to have jobs that required them to spend a large amount of time with hands above shoulder level, jobs that required a large amount of standing, and jobs that required a large amount of heavy lifting.'' This admission, without providing further data, makes interpretation of results difficult. It is impossible to tell whether the study sample reflects the overall original sample population. By loss of those exposed to heavy lifting or working with hands above shoulder one cannot assess whether this would have minor or major impact on the findings. Changes in job situations after 1990 were also not recorded, which would weaken association between job factors and neck pain. In responders without neck pain during the previous 12 months in 1990, the ''little influence on own work situation'' factor predicted neck pain during the previous 12 months (odds ratio = 2.21; 95% confidence interval, 1.18 to 4.14) and previous 7 days in 1994 (OR = 2.85; 95% confidence interval, 1.21 to 6.73) after adjustment for a series of potential confounders. Because of the serious questions with regard to changes in population exposure over time, OSHA believes the results are not interpretable and it was not included in Table V–1.

Biomechanical Evidence

In a series of biomechanical and EMG studies, Harms-Ringdahl (1986, Ex. 26–1128) demonstrated that considerable stress is generated in the ligaments and joint capsule of the cervical spine with extreme neck flexion (more than 45 degrees). The extensor muscle activity is less than in the neutral position while the load moment (or torque) is 3–4 times greater in extreme flexion.

Many hand-intensive jobs and tasks require static neck contraction to permit accuracy in task performance. Thus, significant muscle stress and fatigue may occur with maintenance of static neck postures required in many office and assembly workplace settings (Hales and Bernard 1996, Ex. 26–896; Bernard and Fine 1997, Ex. 26–1; Onishi, Sakai, and Kogi 1982, Ex. 26–991; Stock 1991, Ex. 26–1010; Westgaard and Bjorklund 1987, Ex. 26–239). In confirmation of this postulate, several EMG studies have documented the increase in neck and upper back muscle activity from static work (Erdelyi *et al.*1988, Ex. 26–619; Onishi, Sakai, and Kogi 1982, Ex. 26–991; Schuldt *et al.*1987, Ex. 26–670). Hidalgo *et al.,* 1992 (Ex. 26–631) reviewed the biomechanical literature of the neck and proposed that prolonged static contraction of neck muscles be limited to force levels at or below 1% of maximum voluntary contraction (MVC).

It has also been shown that workplace interventions to mitigate static loading of neck muscles reduce pain, time out of work due to musculoskeletal problems, and EMG measured loading. Aaraas (1994a, Ex. 26–892; 1994b, Ex. 26–62) evaluated users of video display terminals (VDTs) and assembly workers before and after ergonomic interventions consisting of changes in the workstations, tools, and work organization alterations. In assembly workers, mean static trapezius load decreased from 4.3% to 1.4% of MVC, and in VDT users, MVC declined from 2.7% to 1.6%. This was accomplished with more accessible tool placement and support for elevated arms. The median duration for sick leave resulting from MSDs dropped from 23 to 2 days per person/year. As a result of interventions, including the reduction in trapezius loading, the VDT operators also reported less intensity and duration of pain in the neck and shoulder region. The study design did not permit the determination of which intervention(s) were responsible for the decline in MVC and sick leave, but it does support the role of workplace ergonomics.

While epidemiologic studies regarding vibration and non-discogenic neck and shoulder pain have been inconclusive, there is some biomechanical evidence that vibration may affect muscle activity, and therefore could be pathogenic for neck disorders. This is a complex area, particularly since the most common shoulder diagnoses—impingement and rotator cuff tendinitis—are clinically useful but without very specific pathophysiologic meaning. In the following review (Appendix I, Ex. 27–1), the neck, but not the shoulder, is shown to be associated with a vibration-related pathology. The separation of biomechanical, physiologically adaptive, and vibration-specific factors is especially difficult for the neck and shoulder. Scapular stability and posture are the heart of large-muscle activation sequences involving efficient distal muscle group movement (Mackinnon and Novak 1997, Ex. 26–1309). Moreover, static shoulder posture, important for tool stabilization, is an important contributor to early arm fatigue (Sjogaard *et al.*1996, Ex. 26–213). Finally, the quality of a vibratory stimulus (continuous or discrete) has significant impacts on efferent recruitment and firing (Maeda *et al.*1996, Ex. 26–562). The combined effects of this complexity are not easily modeled. This is all the more reason why neck/shoulder symptoms should be carefully scrutinized when a power tool is part of the exposure background. It may prove difficult in practice to distinguish neck/shoulder symptoms that have their origins in strictly biomechanical processes from vibration-induced injuries. However, there is sufficient evidence in support of an etiology to merit intervention.

As discussed earlier, skeletal muscle activity involves oxygen and energy consumption and metabolic end-product generation. Repeated damage from overuse without adequate recovery time for repair therefore has the potential to cause permanent structural damage to skeletal muscle (Armstrong *et al.*1993, Ex. 26–1110). Thus, work pacing can reasonably be expected to affect muscle function in the neck. Froberg *et al.*(1979, Ex. 26–117) compared female production workers performing piece work vs. salaried work. Piece work was associated with increased pain in the shoulders, arms, and back, accompanied by elevated excretion of adrenalin and noradrenalin.

Unfortunately, financial incentives in piece workers may encourage workers to avoid pacing themselves in an effort to exceed production levels. Brisson *et al.*(1989, Ex. 26–937) postulated that the biomechanical stressors involved with piece work performed by female garment workers in Quebec, and the time pressures imposed by their piece work, combined to account for observed disability from MSDs. The association was related to the number of years performing piece work, and was independent of age, smoking, education, and total length of employment. In addition, some researchers suggest that workers may ignore early warning symptoms of work-related MSDs.

Conclusion

The 1997 NIOSH report concluded the following with regard to physical work factors and MSDs of the neck/shoulder region:

> There is strong evidence that working groups with high levels of static contraction, prolonged static loads, or extreme postures involving the neck/shoulder muscles are at increased risk for neck/shoulder MSDs. Consistently high ORs were found (twelve statistically significant studies with ORs over 3.0) providing evidence linking tension neck syndrome with static postures and static loads (Ex 26–1).

OSHA agrees with NIOSH with regard to the epidemiological evidence for an association between neck and neck/shoulder MSDs and physical risk factors related to forceful exertion, repetitive motion and awkward posture. Twelve out of thirteen well-conducted epidemiological investigations that directly observed or measured these factors in the workplace have found a significantly elevated risk of neck/shoulder MSDs in exposed workers verified by physical exam. This link between physical work factors and injury has been established across numerous job areas including VDT operation (Hunting 1981, Ex. 26–1276; electronics manufacture (Kilbom 1986, Ex. 500–41–75; Jonsson 1988, Ex. 26–969) and fish processing (Nordander 1999, Ex 38–408). Several reviews have concluded that specific neck disorders, such as tension neck syndrome, are consistently associated with repetitive work and prolonged static loads and postures of the neck (Hagberg *et al.*1995, Ex. 26–432; Kourinka and Forcier 1995, Ex 26–432; Grieco *et al.*1998, Ex. 26–627).

The epidemiological evidence is supported by what is known about the biomechanics and pathogenesis of these neck disorders. It has been consistently shown by EMG that extreme postures and static loads on the neck/shoulder increase the internal force on the neck muscles Harms-Ringdahl *et al.*1986, Ex. 26–136; Higado *et al.*1992, Ex. 26–631). Prolonged and frequent stress on these structures leads to muscle fatigue and reduced blood flow. The combination of high oxygen demand and low supply creates ischemia of the surrounding tissue and neck pain. Repeated episodes of stress does not allow adequate recovery time for repair raising the potential for long-term damage to the neck muscles (Armstrong 1993, Ex. 26–1110). OSHA concludes that a combination physical work-related factors, such as repeated movements of the upper arm and shoulder, static loads on the neck/shoulder, and extreme postures of the neck, are able to cause substantial and serious impairment to the neck and shoulder.

Muscoskeletal Disorders of the Shoulder

Much of the evidence that relates physical work factors to shoulder disorders focuses on shoulder tendinitis. To understand how force, repetitive motion, and awkward postures lead to tendon injury one must understand tendon function and repair mechanisms. As muscles contract, tendons are subjected to mechanical loading and viscoelastic deformation. Tendons must have both tensile resistance to loading (to move attached bones) and elastic properties (to enable them to move around turns, as in the hand). When collagen bundles are placed under tension, they first elongate without significant increase in stress. With increased tension, they become stiffer in response to this further loading. If the load on these structures exceeds the elastic limit of the tissue (its ability to recoil to its original configuration), permanent changes occur (Ashton-Miller 1999, Ex. 26–414; Moore 1992a, Ex. 26–985; Chaffin and Andersson 1991, Ex. 26–420). During subsequent loading of the damaged tendon, less stiffness is observed. The ultimate strength of normal tendon and ligament is about 50% of that of cortical bone (Frankel and Nordin 1980, Ex. 26–1125), but structures that have exceeded the elastic limit fail at lower limits. In addition, if recovery time between contractions is too short, deformation can result in pathologic changes that decrease the tendon's ultimate strength (Thorson and Szabo 1992, Ex. 26–1171; Goldstein *et al.*1987, Ex. 26–953). Tendon exhibits additional viscoelastic properties of relaxation and creep. That is, when a tendon is subjected to prolonged elongation and loading, the magnitude of the tensile force will gradually decrease (relaxation) and the length of the tendon will gradually increase (creep) to a level of equilibrium (Chaffin and Andersson 1991, Ex. 26–420; Moore 1992a, Ex. 26–985; Woo *et al.*1994, Ex. 26–596). During repetitive loading, the tendon exhibits these properties and then recovers if there is sufficient recovery time. If the time interval between loadings does not permit restoration, then recovery can be incomplete, even if the elastic limit is not exceeded (Goldstein *et al.*1987, Ex. 26–953).

Shoulder tendinitis includes supraspinatus and bicipital tendinitis. Bicipital tendinitis results when the tendon of the biceps brachii muscle rubs on the lesser tuberosity of the humerus bone, which occurs with motion of the shoulder (glenohumeral) joint during overhead arm movements. Persons affected with this disorder experience pain and tenderness in the shoulder area during shoulder flexion, elbow extension and forearm supination, or when the elbow and arm are extended and the forearm is supinated. Supraspinatus tendinitis is also known as rotator cuff disorder, subdeltoid tendinitis, subacromial tendinitis, or partial tear of the rotator cuff. Affected individuals commonly have pain in the front of the shoulder which is accentuated when they attempt to raise the arm away from the body (abduct the arm), although other movements may also be painful.

There are multiple plausible theories for the pathogenesis of disorders of the rotator cuff. For purposes of this review, it is assumed that supraspinatus tendon tears and calcification represent endpoints of one pathological process as opposed to separate and unique endpoints. Mechanisms related to disorders of the rotator cuff complex with acute onset are excluded from this discussion (*e.g.,* strains, falls, dislocations).

The presence of a watershed or avascular zone in the supraspinatus tendon has been described and demonstrated by several investigators (Moseley and Goldie 1963, Ex. 26–306; Rothman and Parke 1965, Ex. 26–499; Rathbun and Macnab 1970, Ex. 26–1376). It is believed that the avascular zone compromises the ability of the tenocytes within this portion of the tendon to repair damage to collagen fibers or their matrix. This impaired ability to repair the tendon implies that degenerative changes within this portion of the tendon will accumulate over time; therefore, the degree and progression of tendon degeneration will increase with increasing exposure to potential sources of injury, age, or both. Potential sources of injury to the tendon's collagen fibers or matrix may be ischemic, mechanical (impingement), or physiological (contractile load).

According to the ischemia theory, the function and viability of the tenocytes within the supraspinatus tendon are compromised because they are in an avascular zone; therefore, they are unable to sustain the normal structure of the tendon over one's lifetime. This lack of maintenance manifests itself as degenerative changes within the substance of the tendon. The positive correlation between the prevalence of supraspinatus tendon degeneration and tears with age is consistent with this theory. It is not clear that task variables related to work are necessary in this pathogenetic model; however, Rothman and Macnab (1970, Ex. 26–499) postulated that shoulder adduction with neutral rotation would subject this avascular portion of the tendon to pressure from the humeral head, thus ''wringing out'' the blood from this already avascular area. If this were true, the duration of shoulder adduction is probably more important than the number of shoulder adductions.

Neer (1972, Ex. 26–185) proposed that the subacromial bursa and supraspinatus tendon were mechanically impinged on the underside of the anterior aspect of the acromion process or coracoacromial ligament as the shoulder approached 80 degrees abduction or flexion when internally or externally rotated. Below 80 degrees flexion or abduction, the greater tuberosity of the humerus is generally not in immediate contact with the acromion process or the coracoacromial ligament. Beyond this degree of elevation, the humeral head is displaced down and away from the acromion and the ligament, thus relieving these structures of this contact stress. This contact stress is postulated to cause disruption of collagen fibers within the tendon mechanically. This mechanism of collagen disruption may (or may not) be combined with the phenomenon of impaired healing related to the avascular zone. The critical relationship between this proposed model of supraspinatus tendon disease and biomechanical task variables is the passage of the shoulder through the 80 degrees abduction or flexion arc. Since this biomechanical stress occurs in a limited portion of these arcs, it is anticipated that the number of times the shoulder performs this task (per unit time) is more relevant than the duration of time the shoulder is in this position. Anatomical variations in the size and shape of the acromion (particularly type II [curved] and type III [hooked]) as well as hypertrophy of tissues related to the coracoacromial arch are also important factors. (Bigliani *et al.*1991, Ex. 26–603; Fu, Harner, and Klein 1991, Ex. 26–464).

Posture plays an important role in rotator cuff tendinitis of the shoulder. Work with the arm elevated more than 60 degrees from the trunk is more stressful for the supraspinatus than work performed with the arm at the trunk. As the arm is raised or abducted the supraspinatus tendon becomes in contact with the undersurface of the acromion. They are in closest proximity between 60 and 120 degrees of arm elevation (Amadio 1995, as cited in Fine and Silverstein 1998, Ex.38–444). The precise pathosphysiology of rotator cuff tendinitis is not known. However, the role of overhead work, particularly of a static nature or very forceful exertions, is likely a crucial event (Andersson 1995 and Levitz and Iannotti 1995, as cited in Fine and Silverstein, 1998, Ex. 38–444). Impingement seems important. One suggested histologic pattern is a reversible inflammatory infiltrate, with increased vascularity and edema within the rotator cuff tendons, especially the supraspinatus tendon. This process, if it becomes chronic, has been postulated as leading to degenerative changes in the tendons. Eventually, enough degeneration occurs that a minor trauma causes or seems to cause a partial rotator cuff tear (Fine and Silverstein 1998, Ex. 38–444).

Another shoulder disorder related to physical work factors is osteoarthritis of the acromioclavicular joint. Osteoarthritis refers to degenerative changes in the cervical spine that are apparent on radiological examination. A combination of high exposure to load lifting and high exposure to sports activities that engage the arm was a risk factor for shoulder tendinitis, as well as osteoarthritis of the acromioclavicular joint (Stenlund *et al.*1993, Ex. 26–1459). Kennedy, Hawkins, and Kristof (1978, Ex. 26–1135) found that 15% of competitive swimmers with repetitive overhead arm movements had significant shoulder disability, primarily due to impingement from executing butterfly and freestyle strokes.

Physical work requires both mechanical and physiological responses, for example, muscle force and energy consumption. The mechanical responses include connective tissue deformation and yielding within the muscle; which increases intramuscular pressure. Increased intramuscular pressure in turn decreases blood flow through the muscle (Armstrong *et al.*1993, Ex. 26–1110).

Nerves, vessels, and other soft tissues may be internally compressed under conditions of high-force exertions, awkward postures, static postures, and/or high velocity or acceleration of movement. For example, strong abduction or extension of the upper arm, as well as awkward postures of the neck, can compress parts of the brachioplexus under the scalene muscles and other anatomical structures. This compression can result in nerve and/or blood vessel damage or eventual damage to the tissues served by these nerves and vessels.

Static postures, postures held over a period of time to resist the force of gravity or to stabilize a work piece—are particularly stressful to the musculoskeletal system. More precisely, static postures are usually defined as requiring isometric muscle force—exertion without accompanying movement. Even with some movement, if the joint does not return to a neutral position and continual muscle force is required, the effect can be the same as a non-moving posture. Since blood vessels generally pass through the muscles they supply, static contraction of the muscle can reduce blood flow by as much as 90%. The consequent reduction in oxygen and nutrient supply and waste product clearance results in more rapid onset of fatigue and may predispose muscles and other tissues to injury. The increased intramuscular pressure exerted on neural tissue may result in chronic decrement in nerve function. The viscoelastic ligament and tendon tissues can exhibit ''creep'' over time, possibly reaching failure thresholds beyond which they are unable to regain resting length.

Chronic reduction of blood flow may be a mechanism by which static muscle contractions lead to MSDs. Several studies have found that the small, slow motor units in patients with chronic muscle pain show changes consistent with reduced local oxygen concentrations (Larsson *et al.*1988, Ex. 26–1140; Dennett and Fry 1988, Ex. 26–104). Reduced blood flow and disruption of the transportation of nutrients and oxygen can produce intramuscular edema (Sjogaard 1988, Ex. 26–206). The effect can be compounded in situations where recovery time between static contractions is insufficient. Eventually, a number of changes can result: muscle membrane damage, abnormal calcium homeostasis, an increase in free radicals, a rise in other inflammatory mediators, and degenerative changes (Sjogaard and Sjogaard 1998, Ex. 26–1322).

Epidemiological Evidence

In its review of the epidemiologic literature on work-related musculoskeletal disorders of the shoulder, NIOSH identified 38 epidemiologic studies that examined workplace factors and their relationship to shoulder MSDs (Bernard 1997, Ex. 26–1). These studies examined the prevalence of shoulder disorders in workers exposed to repeated abduction extension or flexion of the shoulder in combination with strenuous work involving heavy loads or elevated arms. The MSDs were usually shoulder tendinitis or a collection of symptoms defined by stiffness, pain, and weakness. Table V–2 summarizes some key aspects of these investigations, such as the occupations examined, the biomechanical risk factors the workers were exposed to, whether exposures were directly observed or measured during the study, and whether the health outcomes were verified by trained medical personnel during physical examination. Sixteen of the studies relied on direct observation or measurements of exposure and verification of shoulder injury by physical exam. EMG of the forearm flexor muscles, frequency of shoulder movements, or angle of shoulder flexion were quantitatively measured in some of these studies. Another 24 studies relied either on job title information or questionnaire to obtain exposure information and/or used self-reported symptoms to define cases of shoulder MSDs. OSHA considers these investigations to be less reliable. All twelve studies with exposure and medical verification reported statistically significant associations between shoulder disorders and the physical work factors. The odds ratios reported in these studies ranged between 1.6 and 46. The wide range in risks probably relates to differences in magnitude of exposure and case definition among the studies.

TABLE V–2.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING MUSCULOSKELETAL DISORDERS OF THE SHOULDER

Study	Job type studied	Physical factors	Exposure basis	Physical exam	Risk measure (95% CI) [1]
Hughes (1997) Ex. 26–907	Aluminum smelter	F/R?/P	Checklist	Yes	OR=46* (3–550)
Herberts (1981) Ex. 26–51; (1984) Ex. 26–960	Shipyard welding	F/R?/P	Observation EMG	Yes	PRR=15–18* (14–22)
Bjelle (1979) Ex. 26–1112	Industry case control	F?/R/P	Observation	Yes	OR=10.6* (2.3–54.9)
Frost (1999) Ex. 500–205–4	Slaughter-house	F/R/P	Observation	Yes	OR=5.3–7.9* (2.9–21.2)
Onishi (1976) Ex. 26–1222	Multiple jobs	F/R/P	Observation cycle time.	Yes	OR=1.1–6.0* (3.0–12.2)
Ohlsson (1995) Ex. 26–868	Assembly line	F?/R/P	Flexion cycle time	Yes	OR=4.2* (1.4–13.2)
Baron (1991) Ex. 26–967	Grocery checking	F/R/P	Job titles	Yes	OR=3.9* (1.4–11.0)
Ohlsson (1994) Ex. 26–1189	Fish processing	F/R/P	Observation freq./angles.	Yes	OR=3.5* (1.6–7.2)
Nordander (1999) Ex. 38–408	Fish processing	F?/R/P	Observation	Yes	OR=3.5* (2.5–5.3)
Punnet (2000) Ex. 500–41–109	Auto workers case/control.	F/R/P	Cycle/flexionlift load	Yes	OR=1.1–4.0* (1.7–9.4)
Chiang (1993) Ex. 26–1117	Fish processing	F/R/P?	Cycle time EMG	Yes	OR=1.6–1.8* (1.2–2.5)
Kilbom (1987) Ex. 26–1277; Jonsson (1988) Ex. 26–833.	Electronics manufacture.	F/R/P	MVC, flexion cycle time.	Yes	NR*
Bjelle (1981) Ex. 26–1519	Industrial plant	F/R/P	Flexion EMG	Yes	NR*
Sakakibara (1995) Ex. 26–800	Fruit bagging	F?/R?/P	Observation arm elevation.	Yes	NR*
Zetterberg (1997) Ex. 26–899	Auto assembly	F/P	Cycle time tool weight.	Yes	NR
English (1995) Ex. 26–848	Patients case/ control.	F/R/P	Question- naire	Yes	OR=2.3* (NR)
Andersen (1993) Ex. 26–1451	Sewing machine	F/R/P?	Job titles	No	OR=3.2* (1.7–7.4)
Andersen (1993) Ex. 26–1502	Sewing machine	F/R/P?	Job titles	Yes	NR*
Stenlund (1992) Ex. 26–733; (1993) Ex. 26–1459	Rockblasting bricklaying.	V/F/R?	Questionaire	Yes	OR=0.4–4.0* (1.8–9.2)
Wells (1983) Ex. 26–729	Letter carrier	F/R?/P	Job title	No	OR=5.7* (2.1–17.8)
Hoekstra (1994) Ex. 26–725	Video terminal	R/P	Observation	No	OR=5.1* (1.7–15.5)
Schibye (1995) Ex. 26–1463	Sewing machine	F?/R/P?	Questionaire	No	NR
Burdorf (1991) Ex. 26–454	Riveting	V	Tool aceleration	No	OR=1.5* (NR)
Bergenudd (1988) Ex. 26–1342	Multiple industries	F/R?/P?	Questionnaire	No	NR
Burt (1990) Ex. 26–698	Computer entry	R/P	Job title	No	OR=2.6–4.1* (1.8–9.4)
Floodmark (1992) Ex. 26–1209	Vent shaft production	F?/R?/P?	Job title	No	OR=2.2* (1.4–4.4)
Hales (1989) Ex. DC–139–D	Poultry processing	F/R	Job title	Yes	OR=0.9–3.8* (0.6–22.8)
Hales (1994) Ex. 26–131	Telecommunication	R/P	Questionnaire	Yes	NR
Ignatius (1993) Ex. 26–1389	Postal work	F/R/P	Job title	No	OR=1.8–2.2* (1.5–3.1)
Kiken (1990) Ex. 26–430	Poultry processing	F/R/P?	Job title	Yes	OR=1.6–4.0 (0.6–29)
Kvarnstrom (1983) Ex. 26–1201	Factory/office	F/R/P?	Questionnaire	Yes	RR=2.2–5.4 (NR)
McCormick (1990) Ex. 26–1334	Textile	F/R/P?	Job title	Yes	OR=1.1–1.3 (0.5–3.8)
Ohara (1976) Ex. 26–1	Cash register	F?/R?/P?	Job title	Yes	OR=1.7–2.2* (1.4–3.5)
Ohlsson (1989) Ex. 26–1290	Auto assembly	F/R/P?	Job title	No	OR=2.0–3.4* (1.6–7.1)
Punnett (1985) Ex. 26–995	Garment	R/P?	Job title	Yes	OR=2.2* (1.0–4.9)
Rossignol (1987) Ex. 26–804	Computer operation	R/P	Questionnaire	No	OR=2.5–4.8* (1.6–17.2)
Sweeney (1994) Cited Ex. 26–1	Sign language interpreter.	R/P?	Questionnaire	Yes	OR=2.5 (0.8–8.2)
De Zwart (1997) Ex. 26–617	Various occupations	F/R?/P?	Questionnaire	No	OR=1.25–2.5* (p<0.001)

TABLE V–2.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING MUSCULOSKELETAL DISORDERS OF THE SHOULDER—Continued

Study	Job type studied	Physical factors	Exposure basis	Physical exam	Risk measure (95% CI) [1]
LeMasters (1998) Ex. 500–121–44; Bhattacharya (1997) Ex. 500–121–7; Booth-Jones (1998) Ex. 500–121–9.	Carpenters	F/R/P	Observation, measurement.	Only small subset.	OR=2.3–3.2* (1.1–8.9)
Pope (1997) Ex. 32–137–1–4	Various occupations	F/R?/P	Questionnaire	No	OR=2.1–5.5* (1.8–17.4)
Botha (1998) Ex. 500–121–10	Nurses	F/R?/P	Questionnaire, observation.	No	NR
De Joode (1997) Ex. 500–121–72	Ship maintenance	F/R?/P	Strain gauge	No	RI=1.7–3.9 (NR)

F=forceful exertions; R=repetitive motion; P=awkward posture; IR=incidence rate; OR=odds ratio; PRR=prevalence rate ratio; RI=risk index; NR=not reported; ?=presence of risk factor unclear.
*p<0.05.
[1] 95% confidence interval expressed for the upper end of the risk measure range.

The NIOSH noted several well-conducted studies that provided evidence of an exposure—response and temporal relationships. Chiang *et al.*(1993, Ex. 26–1117) divided 207 fish processing workers into three exposure groups based on EMG measurements of forearm flexor muscles and cycle time measurements of shoulder movements of representative job tasks. Exposure groups were: (1) Low force, low repetition (comparison group); (2) high force or high repetition; and (3) high force and high repetition. Shoulder girdle pain was the health outcome as defined by symptoms and palpable hardenings upon physical examination. The results showed a significant increasing trend in the prevalence of shoulder pain from group 1 (10 percent) to group 3 (50 percent).

In another cross-sectional study, Ohlsson *et al.*(1995, Ex. 26–868) compared a group of 82 women who performed industrial assembly work requiring repetitive arm movements with static muscular work of the neck/shoulder with a referent group of unexposed women. The frequency, duration, and critical angles of movement were measured from videotape and observation. Shoulder MSDs such as tendinitis, acromicroclavicular syndrome, and frozen shoulder were determined from symptoms and physical exam. The risk of shoulder tendinitis in the exposed women was significantly greater than the unexposed women (OR=4.2; 95% CI 1.4–13.2). The neck and shoulder disorders were also significantly (p<0.05) associated with the number and duration of shoulder elevations greater than 60 degrees. The study of Bjelle *et al.*(1981, Ex. 26–1519) also found that the frequency of shoulder abduction and forward flexion past 60 degrees was significantly greater (p<0.05) for cases with neck/shoulder disorders than for controls.

In a prospective study design, Kilbom *et al.*(1986, Ex. 500–41–75; 1987, Ex. 26–1277) assessed the health and exposure status of 06 electronics manufacturing plant employees over a two year period. The employees were evaluated for maximum voluntary isometric contraction (MVC) of the forearm flexors and shoulder strength. Videotape was used to analyze cycle time and working postures and movements. Shoulder MSDs were determined annually based on interview and physical examination assessing tenderness on palpation as well as pain and restriction upon shoulder movement. Symptom severity was also scored. Logistic regression analysis showed significant relationship (p<0.05) between MSDs and percentage of work cycle time with upper arm elevated. The number of elevations per hour was a strong predictor for increases in symptom severity over the study period. A follow-up investigation also found that the percent of the work cycle spent with the shoulder elevated was negatively associated with remaining symptom-free (Jonsson *et al.*1988, Ex. 26–833).

NIOSH concluded that there was evidence for a positive association between highly repetitive work and shoulder MSDs. Only three studies specifically address the health outcome of shoulder tendinitis and these studies involve combined exposure to repetition with awkward shoulder postures or static shoulder loads. The other six studies with significant positive associations dealt primarily with symptoms. There was evidence for a relationship between repeated or sustained shoulder posture with greater than 60 degrees of flexion and abduction and shoulders MSDs. This holds for both shoulder tendinitis and nonspecific shoulder pain. NIOSH found insufficient evidence for a positive association between either force or vibration and shoulder MSDs because the studies that principally examined this risk factor relied on self-reported questionnaires for assessment of exposure and health outcome.

Twelve studies that address physical work factors and shoulder MSDs were submitted into the OSHA docket following publication of the proposal (Zetterberg *et al.*Ex. 26–899; De Zwart *et al.*1997, Ex. 500–121–18; Punnett *et al.*2000, Ex. 500–41–109; LeMasters *et al.*Ex. 500–121–9; Bhattacharya *et al.*1997, Ex. 500–121–7; Booth-Jones *et al.*1998; Ex. 500–121–44; Pope *et al.*1997, Ex. 500–71–42; Frost and Anderson 1999, Ex. 500–41–57; Burdorf *et al.*1997, Ex. 500–71–24; Van Wendel de Joode 1997, Ex. 500–121–72; Botha and Bridger 1998, Ex. 500–121–10). Many of these studies showed that high physical loads in combination with elevated shoulder positions were associated with increased prevalence of shoulder disorders (Ex. 500–121–9; Ex. 500–121–7; Ex. 500–121–44; Ex. 500–41–57; Ex. 500–41–109; Ex. 500–121–18; Ex. 500–121–10; Ex. 500–121–72; Ex. 26–899). For example, Frost and Anderson (Ex. 500–41–57) found a strong significant association (OR>5) among meat packers who worked extensively with arm elevation greater than 30 degrees more than 10 times per minute and prevalence of rotor cuff tendinitis compared to those with no shoulder elevation. The risk increased with cumulative exposure years. Punnett *et al.*(Ex. 500–41–109) reported a significant association between repeated shoulder abduction/flexion and shoulder disorders. There was evidence of exposure—response with frequency of shoulder movements to 90 degrees flexion or abduction. Shoulder

MSDs were confirmed by physical examination in both studies.

Biomechanical Evidence

Rohmert (1973, Ex. 26–580) found that muscle contractions can be maintained for prolonged periods if kept below 20% of MVC. But other investigators (Westgaard and Aaras 1984, Ex. 26–1026) found chronic deleterious effects of contractions even if they are lower than 5% of MVC. This latter finding is supported by the observation that low-level static loading (such as shoulder loading in keyboard tasks) is associated with shoulder MSDs (Aaras *et al.*1998, Ex. 26–597). The supraspinatus muscle, a muscle severely constrained by bone and ligamentous tissue, demonstrates increased intramuscular pressure during small amounts of shoulder abduction or flexion (Jarvholm *et al.*1990, Ex. 26–285). Tichauer (1966, Ex. 26–1172) looked at the impact of arm posture on trapezius stress. He noted that arm abduction to 40 degrees increased stress in the upper trapezius muscle eight times as much as when the arm was abducted to 20 degrees, and 64 times as much as at a 10 degrees. These study results suggests the possibility of chronic blood vessel and nerve compression during static tasks. Other laboratory evidence for muscle and tendon damage in these areas, as well as secondary compression of blood vessels and nerves, lends support to the connection between work-related static postural requirements and the development of these disorders.

Biomechanical studies of shoulder posture show that muscle activity and subjective fatigue in the shoulder region increases as a function of shoulder elevation angle and load moment at the shoulder joint. There is also evidence of localized muscle fatigue based on a shift in the MPF of the EMG spectrum. Prolonged periods of neck flexion cause increased levels of discomfort and increased EMG activity in the neck extensor muscles.

Herberts, Kadefors, and Broman (1980, Ex. 26–1129) measured EMG activity as a function of static shoulder posture in a laboratory study using 10 male subjects. The primary independent variable was posture. Subjects held a 2-kg load in the hand at waist, shoulder, and overhead heights using different combinations of flexion and abduction at the shoulder. EMG activity was measured using wire electrodes in the anterior and posterior portions of the deltoid, the supraspinatus, the infraspinatus, and the upper portion of the trapezius. Localized fatigue (a shift in EMG mean power frequency [MPF]) was observed in all muscle groups during shoulder-level and overhead work ($p<.05$) during the 1-minute trials. Even at waist level, fatigue was observed when the upper arm was abducted at an angle of 30 degrees.

Hagberg (1981, Ex. 26–955) measured EMG activity and discomfort in the shoulder in a laboratory study of six female subjects. Surface electrodes recorded EMG activity in the descending trapezius, anterior deltoid, and biceps brachii while subjects performed repeated flexion of the shoulder every 4 seconds to an angle of 90 degrees for a period of 60 minutes. Heart rate and perceived exertion using Borg's scale was also recorded. Hand load was the independent variable: weights of 0.6 kg, 1.6 kg, and 3.1 kg were held in the hand (in addition to a no-load treatment). Heart rate and perceived increased over the course of the trial. Heart rate and perceived were greater when a load was held in the hands. EMG activity in the trapezius was closely correlated with the external moment at the shoulder joint.

Oberg, Sandsjo, and Kadefors (1994, Ex. 26–867) measured EMG activity and subjective discomfort in the shoulder-neck region in a laboratory study of 20 subjects (10 male, 10 female). Surface electrodes measured EMG activity in the right trapezius muscle while subjects abducted the arm to a 90 degree angle. Subjects reported fatigue using the Borg 10-point scale. Each subject was tested under two conditions: a 5-minute test with no load in the hand and a 2.5 minute test with a 2-kg load in the hand. At the no-load level, there was no change in EMG MPF over the course of the trial; however, subjective fatigue increased. With the 2-kg. load, there was a small linear decrease in MPF over the trial and there was a negative correlation between MPF and the Borg rating ® = 0.46). The authors concluded that MPF was not a good proxy for perceived fatigue during low-intensity static exertions of the shoulder.

Using EMG, several investigators have demonstrated that the supraspinatus muscle is activated throughout most of the range of motion of the shoulder. Herberts and Kadefors (1976, Ex. 26–470) and Herberts *et al.*(1984), Ex. 26–960 postulated that the level of tension in the supraspinatus muscle during arm elevation (with or without holding an object in the hands) was sufficiently high to increase intramuscular pressure to a point sufficient to compromise intramuscular circulation. As reported by Edwards, Hill, and McDonell (1999; Ex. 26–1232), intramuscular pressures of 20 mm Hg may be sufficient to prevent muscular perfusion. Since many of the blood vessels within the tendon are longitudinal extensions of the blood vessels in the muscle belly, reduced perfusion of the intramuscular blood vessels implies reduced perfusion of the intratendinous blood vessels. If this reduced perfusion is sustained for sufficient durations of time, the tenocytes or other tendon components are susceptible to ischemic injury. In terms of biomechanical task variables, experimental data suggest that overhead work may cause intramuscular pressures capable of reducing intramuscular perfusion. Lifting combined with arm elevation (shoulder load) also contributes to the magnitude of supraspinatus muscle activation. From a temporal perspective, this proposed model is more related to the duration of the intramuscular pressure than to its frequency.

After reviewing the scientific literature, Winkel and Westgaard (1992a, Ex. 26–1163) recommended less than 4 hours of work requiring overhead or extended reach postures. For continuous work, they recommended exposure times of one hour or less, particularly if the work involved highly repetitive tasks, low worker control, or a lack of alternating tasks. When large forces are also exerted, they recommended that the exposure time should be even less.

Wiker, Chaffin and Langolf (1999; Ex. 26–1028) used psychophysical methods to investigate the relationship between strength capacity of the shoulder complex and fatigue/discomfort induced by sustained awkward arm postures in simulated light assembly work. Awkward shoulder postures (arms above shoulder level) produced severe discomfort at less than 10% MVC within one hour and were unrelated to subject strength. These authors recommended elimination of overhead work even in light-weight manual assembly environments, irrespective of individual worker strength or anthropometry.

Conclusion

The 1997 NIOSH report made the following statement with regard to the epidemiological evidence that links physical work factors and shoulder tendinitis:

> The evidence for specific shoulder postures is strongest where there is combined exposure to several physical factors like holding a tool while overhead. The strength of the association was positive and consistent in six studies that used diagnosed cases of shoulder tendinitis or a combination of symptoms and physical findings consistent with tendinitis as the health outcome (Ex. 26–1).

OSHA agrees with NIOSH with regard to the epidemiological evidence for an association between shoulder tendinitis and a combination of physical risk factors related to sustained or repeated shoulder flexion and abduction, particularly when it includes an additional static hand load such as working overhead. Fifteen out of sixteen well-conducted epidemiological investigations that directly observed or measured these factors in the workplace have found a significantly elevated risk of shoulder MSDs in exposed workers verified by physical exam. This link between physical work factors and injury has been established across numerous job areas including assembly line work (Punnett et al.1998, Ex. 38–155; Ohlsson et. al. 1995, Ex. 26–868), electronics manufacture (Kilbom 1986, Ex. 500–41–75; Jonsson 1988, Ex. 26–969) and fish processing (Nordander *et al.*1999, Ex 38–408; Chiang *et al.*1993).

The epidemiological evidence is supported by biomechanical studies and the pathogenesis of these shoulder disorders. It has been consistently shown by EMG that fatigue in the shoulder muscles occurs with abduction and flexion of the shoulder. Addition of a static load or requiring the arm/shoulder motion be performed repeatedly merely increases both muscle fatigue and perceived discomfort. Over time, these repeated actions stress the tendons in the shoulder causing gradual loss of elasticity and strength. Once the damage exceeds the reparative capacity of the tissue, ischemia sets in and the tendon becomes inflamed, resulting in a chronic tendinitis. The rotator cuff is particularly vulnerable to this pathology since muscles and tendons are already somewhat constrained by ligaments and bone. Severe postures can result in impingement of nerves and blood vessels further aggravating the injury. OSHA concludes that sustained or repeated exertions with the arms and shoulders in awkward postures, such as raised overhead, can increase the risk of substantial and serious impairment to the shoulder. During OSHA's hearing on it's proposal, a nurse who injured her back at work provided compelling testimony. Maggie Flannigan, a registered nurse with 19 years experience in various newborn ICUs (intensive care units) across the country told her story for inclusion in OSHA's rulemaking record. Ms. Flannigan reported having back, neck and shoulder pain for years while working and also after work. Then, while moving a 75-pound monitor down from, then back onto a five-foot high shelf, she sustained a severe injury to her upper back and shoulders. Ms. Flannigan said that other nurses had been injured doing similar tasks, but because

when people think of newborn ICU, they think of, okay, you've got a one-pound baby, so where are your stressors coming from? And they don't realize that we are responding to alarms in high places, that we're doing awkward postures and reaches, and we're pushing heavy equipment, and then sometimes we actually lift heavy equipment which, in my case, gave me a back injury.

It took Ms. Flannigan eight months of treatment to recover and she is fearful of re-injury:

I'm fearful of what's going to happen to me as I age. And I'm also fearful of losing my ability to work as a nurse. I love my profession. I wouldn't trade it. * * * Since I've been injured at work, my family really suffered. I couldn't bathe my children. I couldn't dress them, couldn't do the laundry. My five-year-old buckled my three-year-old in the car seat if I had to drive. He pushed the cart at the grocery store—my five-year-old pushed the shopping cart.

Ms. Flannigan stated further :

I know I'm not the first one hurt at my job, but what I can't live with is I won't be the last unless we start protecting American workers immediately with this ergonomic proposal so we can remove the ergonomic hazards or reduce them in the workplace. American workers deserve a place of employment free from recognized hazards because when a worker develops an MSD, it's not just a lost workday. It can be a life lost forever to pain and disability.

D. Disorders of the Upper Extremities

This section summarizes the evidence that exposure to physical risk factors at work contribute to the pathogenesis of specific musculoskeletal disorders (MSDs) of the upper extremities. In this section, the upper extremities of interest are the elbow, forearm, wrist, and hand. The bulk of the evidence demonstrating a work-related risk center around five MSD classifications; these are epicondylitis, tendinitis of the hand and wrist, carpal tunnel syndrome, hand-arm vibration syndrome, and hypothenar hammer syndrome. There is an impressive body of data that address the role of three biomechanical risk factors in epicondylitis, tendinitis, and carpal tunnel syndrome. These risk factors are force exerted on the muscle, tendons, and nerves; repetitive motion involving the hands, wrists, and forearms; and awkward postures of the wrist and arm. Exposure to these factors often occurs concurrently in occupational settings and the evidence shows that the risk of injury is greatest when more than one factor is present. There are also studies that relate another biomechanical work factor, vibration from the use of hand-held power tools, to an increased risk of carpal tunnel syndrome and hand-arm vibration syndrome. Repeated impact or contact stress, as well as vibration, have been implicated in the development of hypothenar hammer syndrome. Contact stress can, itself, be viewed as a specific combination of repetitive motion and force applied directly to a localized area of tissue, in this case the palm.

There are several types of evidence that continue to support force, repetition, awkward posture, and vibration as causative factors for MSDs of the upper extremities. Information on pathophysiology provides evidence that links exposure to risk factors to the physiological, anatomical, and pathological alterations in soft tissues of the upper extremities. This speaks to the biologic plausibility that work-related risk factors contribute to these injuries. There is voluminous epidemiological data that provide evidence of associations between worker exposure to the identified risk factors and the occurrence of upper extremity MSDs. Some of these studies recently have been reviewed by NIOSH (Bernard and Fine 1997, Ex. 26–1) and were discussed by OSHA in the Health Effects Appendicies to the proposed rule (Ex. 27–1). For the final rule, OSHA has evaluated many additional epidemiologic studies that were entered into the record by many rulemaking participants.

Finally, there is biomechanical and psychophysical laboratory research that complement and corroborate the epidemiological evidence. These approaches are able to directly link exposure to ergonomic risk factors to biomechanical and subjective measurements of tissue response under a more controlled set of simulated work conditions. This evidence derives from studies reviewed in the Health Effects Appendices of the Proposed Rule (Ex. 27–1) and testimony of the many expert scientists that appeared at OSHA's rulemaking hearing. The evidence for each specific MSD covered in this section is discussed in the parts that follow.

Epicondylitis

Epicondylitis is a form of tendinitis that affects the forearm extensor muscle-tendon units that extend from the hand and wrist to the epicondyle (elbow). The most common type is lateral epicondylitis (known as ''tennis elbow'') where the fibrous tissue at the bone-tendon junction (usually the extensor carpi radialis brevis muscle/tendon) on the outer elbow is inflamed. This is believed to be caused by repeated microrupture of the tendon from overuse of the muscles that control the wrists and fingers. Clinical case reports have noted that patients with lateral epicondylitis were often in occupations that involved repetitive, forceful work, particularly repeated pronation and supination movements with the elbow fully extended. For example, in one case series it was reported that 48 percent of patients with lateral epicondylitis of unknown origin had occupations that involved gripping tools with consequent repetitive supination/pronation of the forearm (Sinclair 1965, Ex. 26–736). In a second smaller group of epicondylitis patients reported on in the same publication, 88 percent worked in jobs with constant gripping or repetitive movements.

National surveillance data consistently show that the incidence of this injury is greatest in occupations requiring manually intensive demands on the upper extremities in a dynamic work environment, such as mechanics, butchers, and construction workers. This body of evidence provides ample biological plausibility to the notion that force, repetition, and awkward posture can contribute to this MSD. The interplay between pathophysiology and physical work factors is concisely summarized by Dr. Niklas Krause in his written testimony on the proposed ergonomic standard (Ex. 37–15).

> There always seems to be a mechanical overuse component in MSDs. Tissues react to mechanical stress or overuse or microtraumitization (whatever term is being used) with inflammation leading to edema, swelling, pain, and local repair mechanisms that lead to stiffness and reduced muscle elasticity (probably due to microadhesions of muscle and tendon sheets), inactivity, loss of strength, and, habitual guarding postures, which in turn set the stage for overuse, and so on, in increments. That is why we call these MSDs ''cumulative trauma disorders''. My work on the pathogenesis of the tennis elbow measured the impact of these physiological changes, *i.e.*, increased internal workload or muscle resistance due to reduced tissue elasticity leading to electromyographically detectable recruitment of ever more muscle fibers for the same amount of external workload (which was held constant in these electromyographic studies of isometric muscle action). This increased recruitment of more muscle fibers makes the patient more vulnerable to overexertion at even lower levels of external physical demands * * * until the patient is unable to even lift a cup. [Ex. 37–15]

In a chapter of the *Textbook of Clinical Occupational and Environmental Medicine* (1994, Ex. 38–440), Dr. Martin Cherniak described the symptoms and disabling nature of epicondylitis:

> The characteristic symptoms are pain with lifting , gripping, and wrist extension.* * * Because grip and extension are so central to many jobs, lateral epicondylitis is a condition that can be irreconcilably chronic and produce major and undesirable changes in life and work, despite its seeming mundane nature. [Ex. 38–440, pp. 384–385]

Epidemiological Evidence

NIOSH reviewed 18 cross-sectional studies and one cohort study that addressed workplace risk factors and elbow MSDs. Table V–3 summarizes some key aspects of these investigations, such as the occupations examined, the biomechanical risk factors to which workers were exposed, whether exposures were directly observed or measured during the study, and whether the health outcomes were verified by trained medical personnel during physical examination. Most of the studies compared the prevalence of epicondylitis in workers with jobs known to have highly repetitive, forceful tasks (*e.g.* meat and fish processing) to those engaged in less repetitive, forceful work (*e.g.* office workers). In some cases, the work also involved awkward hand and wrist postures. In almost all the studies, workers were concurrently exposed to a combination of 2 or 3 factors. One study specifically examined vibration from the use of chain saws. Eleven of the studies based case definition on physical examination and worker exposure on observational analysis. Diagnosis of epicondylitis was consistent across studies and required the presence of pain on palpation of the epicondylar area and pain at the elbow upon resisted movement of the wrist. The existence of work-related risk factors was generally made based on job/task observation. Some studies videotaped job tasks and estimated cycle times, static loading on the forearm, and wrist posture in order to qualitatively group workers by exposure intensity. Other studies more subjectively evaluated risk factor exposure by job observation alone. Seven cross-sectional studies reviewed by NIOSH relied strictly on self-reports of symptoms or exposure; OSHA considers these investigations to be less reliable.

TABLE V–3.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING EPICONDYLITIS

Study	Job type studied	Physical factors	Exposure basis	Physical exam	Risk Measure (95% CI) [1]
Hughes (1997) Ex. 26–907	Aluminum smelter	F/R?/P	Checklist	Yes	OR=37* (3–470)
Roquelaure (1996) Ex. 500–41–111	Manufacturing	F/R/P	Checklist	Yes	OR=7.7–18.0* (2.2–147)
Kurppa (1991) Ex. 26–53	Meat processing	F/R/P?	Observation	Yes	IR=6.7* (3.3–13.9)
Chiang (1993) Ex. 26–1117	Fish processing	F/R/P?	Cycle time EMG	Yes	OR=1.2–6.7* (1.6–32.7)
Moore (1994) Ex. 26–1364	Meat processing	F/R/P	Measurement	Yes	OR=5.5* (1.5–62)
Bovenzi (1991) Ex. 26–1433	Forestry	V	Measurement	Yes	OR=4.9* (1.3–56)
SHARP (1993) Ex. 500–41–116	Poultry processing	F/R/P?	Measurement	Yes	NR* (p<0.002)
Dimberg (1987) Ex. 26–945	Automotive	F/R/P	Observation	Yes	NR*
Dimberg (1989) Ex. 26–1211	Automotive	F/R/P	Observation	Yes	NR
Ritz (1995) Ex. 26–1473	Utilities	F/R?/P?	Observation	Yes	OR=1.2–1.7* (1.0–2.7)
Luopajarvi (1979) Ex. 26–56	Food production	F/R/P	Measurement	Yes	OR=2.7 (0.7–15.9)
Baron (1991) Ex. 26–697	Grocery checking	F/R/P	Measurement	Yes	OR=2.3 (0.5–11)
Viikari-Juntura (1991) Ex. 26–1197	Meat processing	F/R/P?	Observation	Yes	OR=0.88 (0.3–2.8)

TABLE V–3.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING EPICONDYLITIS—Continued

Study	Job type studied	Physical factors	Exposure basis	Physical exam	Risk Measure (95% CI)[1]
Roto (1984) Ex. 26–666	Meat cutting	F/R/P?	Job title	Yes	OR=6.4* (1.0–41)
Hoekstra (1994) Ex. 26–725	Video terminal	R/P	Observation	No	OR=4.0* (1.2–13)
Burt (1990) Ex. 26–698	Computer entry	R/P	Job title	No	OR=2.8*) Ex. 26–1.4–5.7)
Punnett (1985) Ex. 26–995	Garment	R/P?	Job title	No	OR=2.4* (1.2–4.2)
Ohlsson (1989) Ex. 26–1290	Assembly line	F?/R/P?	Job title	No	OR=1.5–2.8 (0.8–10.7)
Andersen (1993) Ex. 26–1451	Sewing machine	F/R/P?	Observation	No	OR=1.7 (0.9–3.3)
McCormack (1990) Ex. 26–1334	Textile	F/R/P?	Job title	Yes	OR=0.5–1.2 (0.5–3.4)
Bystrom (1995) Ex. 26–897	Auto assembly	F/R/P	Job title	Yes	OR=0.7 (0.04–1.7)

F=forceful exertions; R=repetitive motion; P=awkward posture; ?=presence of risk factor unclear.
IR=incidence rate; OR=odds ratio; NR=not reported.
*=p<0.05.
[1] 95% confidence interval expressed for the upper end of the risk measure range.

Seven of the 11 studies that relied on objective exposure assessments and medical confirmation of epicondylitis found statistically significant associations between exposure to work-related risk factors and risk of epicondylitis. The most reliable odds ratios (ORs) ranged between 1.0 to 5.5. Some studies deserve special mention. One study was able to divide fish processing workers into a low-force/low-repetition group, a high-force *or* high-repetition group, and a high-force *and* high-repetition group based on observed cycle times and hand forces from electromyography (EMG) recordings of the forearm flexor muscles (Chiang *et al.*1993, Ex. 26–1117). An increasing trend was found in prevalence of epicondylitis with increased exposure intensity (not statistically significant). There was a significant difference between males in the highest exposed group and males in the lowest exposed group (OR=6.75; 95% CI 1.6–32.7), but this trend was not observed among female workers (OR=1.4; 95% CI 0.3–5.6). A prospective cohort study grouped meat processing workers into those engaged in strenuous (primarily cutters and packers) and non-strenuous work (primarily office work) based on repetitive and forceful tasks (Kurppa *et al.* 1991, Ex. 26–53). They reported a significantly increased incidence ratio (6.7; 95% CI 3.3–13.9) of epicondylitis among workers in strenuous jobs over the 31-month follow-up period. Because of the prospective study design, this study provided direct evidence of a temporal relationship between exposure to biomechanical risk factors and the increased incidence of epicondylitis.

One study evaluated vibration as a risk factor for epicondylitis and reported a significantly greater prevalence of epicondylitis (OR = 4.9; 95% CI 1.3–56) in forestry operators using chain saws compared to a comparison group of maintenance workers (Bovenzi *et al.*1991, Ex. 26–1433).

Evidence of exposure-response trends in the epicondylitis literature is limited because of the preponderance of studies that relied on dichotomous comparisons of exposed versus unexposed workers; however, one study found an increase (not statistically significant) in prevalence with the number of hours per week working as a grocery checker (Baron *et al.*1991, Ex. 26–697). Another reported a positive (not statistically significant) exposure-response relationship between duration of exposure to gas and waterworks jobs regarded as stressful to the elbow (Ritz 1995, Ex. 26–1473).

Some unusually high ORs that were reported by a few studies and contained in the NIOSH (1997, Ex. 26–1) review may have been overstated due to bias. For example, one study of aluminum workers reported an OR of 37 between elbow/forearm disorders and the number of years of forearm twisting; however, the overall participation rate in the study was only 55 percent, leaving open the possibility of selection bias (Hughs and Silverstein 1997, Ex. 26–53). The cohort study by Kurppa *et al.*(1991, Ex. 26–53) reported an epicondylitis incidence rate (IR) of 6.7 for workers performing strenuous tasks but counted recurrences in the same elbow as if they were new cases. Reanalysis by NIOSH placed the IR at 5.5 among workers with strenuous jobs versus those with non-strenuous jobs after correcting for recurrent cases.

A few studies reported ORs between 1–3 that were not statistically significant (Baron *et al.*1991, Ex. 26–697; Luopajarvi *et al.*1979, Ex. 26–56). The low risk ratios reported in these studies may reflect the likelihood that the occupations studied (grocery checkers and assembly line food packers) were associated with relatively low forces directed to the forearm extensors combined with insufficient repetitiveness, as compared to other jobs that involve higher forces and more repetition, such as meat cutters/packers where higher prevalence rates of epicondylitis have been found (Moore and Garg 1994, Ex. 26–1364). In addition, cross-sectional studies are often subject to the ‘‘healthy worker’’ effect because of the exclusion of injured workers who may have left the workforce at the time a study was conducted. This can sometimes lead to an underestimation of prevalence.

Most studies adequately controlled for the important confounder of age but the contribution of non-occupational injury to the elbow was often not addressed among groups of workers. The large number of studies reporting a positive association with exposure make it unlikely that non-occupational injuries were an important confounder. Dr. Cherniak emphasized the importance of work rather than non-work activities in the etiology of epicondylitis: ‘‘Its popular epithet of tennis elbow notwithstanding, it is a common condition among industrial workers and is not so common among players of racquet sports.'' [Ex. 38–440, p. 384]

NIOSH concluded that there was some evidence of an association between exposure to force and epicondylitis based on the existence of several studies with quantitative measures of load on the hand/forearm that showed strong ORs (>5) for this risk factor (Moore and Garg 1994, Ex. 26–1364; Chiang *et al.*1993, Ex. 26–1117). NIOSH concluded there was insufficient evidence of an association between epicondylitis and repetition or awkward posture *alone* based on an inadequate number of studies that examined these risk factors as the dominant exposure factor, particularly in any quantitative fashion. However, it is clear that, in many of the epidmiological studies of epicondylitis, repetition and, in some cases awkward posture, accompanied exposure to force (see Table V–3).

Two additional epidemiological studies that address physical work factors and elbow disorders were submitted to the OSHA docket following publication of the proposal (Roquelaure *et al.*1996, Ex. 500–41–111; SHARP 1993, Ex. 500–41–116), which are summarized below and included in Table V–3. Both studies followed an adequate study design, directly observed or measured exposure to workers, and used physical exam to verify the MSD. OSHA, therefore, finds that the studies add substantially to the evidence that the combination of forceful exertion, repetitive motion, and awkward posture increase risk of injury to the elbow.

The Safety and Health Assessment and Research Program (SHARP) of the Washington State Department of Labor and Industries (1993, Ex. 500–41–116) conducted a cross-sectional study of 104 poultry processing workers. Epicondylitis was assessed by interview and physical examination. Exposure was assessed by a risk factor checklist that evaluated repetitiveness, forcefulness, mechanical stress, and wrist deviation. The study found the prevalence of upper extremity MSD by interview was 25% and by physical exam and interview was 17%. The number of repetitive exertions per hour was significantly predictive of epicondylitis (p=0.002).

Roquelaure *et al.*(1996, Ex 500–41–111) reported that work characteristics of greater than 1 kg of hand force, less than 30-second cycle times, and static hand work in workers were associated with radial tunnel syndrome (RTS). RTS is a disorder in which the radial nerve becomes compressed near the elbow causing pain and tenderness, similar to epicondylitis. Roquelaure used a case-referent study of 21 RTS cases and 21 controls while studying 2,250 television, shoe, and brake manufacturing workers. Participation rate was not reported. Referents were age-, gender-, and plant-matched workers selected at random from the same manufacturing population who had no upper limb disorder for the previous eight years. Exposure was determined by direct observation of two trained assessors using a checklist. RTS was determined by reviewing the past two years of medical files of the 2,250 manufacturing workers. A case of RTS was defined as local tenderness 4–5 cm distal to lateral epicondyle, pain in forearm indirectly induced by supination, no peresis or muscle weakness and positive EMG and nerve conduction studies. For 1 kg or greater of hand force, an odds ratio of 18.0 (CI: 2.2–147.5, p=0.01) was reported compared to those cases exposed to less hand force. For workers with less than 30-second cycle times, an odds ratio of 8.7 (CI: 1.2–23.8, p=0.03) was reported compared to those who had longer cycle times. For workers with static hand work, an odds ratio of 7.7 (CI: 1.4–42.7, p=0.02) was reported compared to those involved in more dynamic work. This study demonstrates that an increased risk of RTS is associated with exposure to force, repetition and static posture of the hand.

Two medical experts supplied written testimony on behalf of UPS indicating that epidemiological evidence to support an association between combined biomechanical factors (*e.g.* force, repetition, awkward posture) and the different types of tendinitis of the upper extremities (*e.g.* elbow (epicondylitis), hand/wrist (tenosynovitis)) likely are flawed because of imprecise case definition. Dr. Peter Nathan wrote:

> There is a startling lack of objective evidence to indicate that actual pathology is involved in many of the soft tissue discomfort complaints that are included under the umbrella of cumulative trauma disorders or musculoskeletal disorders—a primary focus of the ergonomic standard. * * * Dr. Armstrong refers to a Finnish study by Luopajarvi *et al.*(1979, Ex. 26–56) which is one of three valid studies referenced by Dr. Susan Stock in her 1991 meta-analysis of the literature relating work exposure to conditions of the neck and upper extremities. The variable representing tendinitis used by Luopajarvi and his colleagues was primarily symptoms confirmed by physical examination. This does not correspond to the classic medical definition of tendinitis, which requires objective evidence of true inflammation (Ex. 500–118).

Similarly, Dr. Nortin Hadler stated in written testimony:

> The health effect in this paper [Kurppa *et. al.* 1991, Ex. 26–53] is a sick leave consequent to regional disorders of the elbow or wrist/hand. The investigators devised their nosology to capture discomfort about the elbow and distal arm/hand. Essentially, all they are describing is localized soreness and/or tenderness. The criterion of swelling or crepitation and tenderness to palpation along the tendon and pain at the tendon sheath, in the peritendinous area, or the muscle/tendon junction during active movement of the tendon boils down to focal soreness/tenderness and nothing more specific or mysterious than that (Ex. 500–118).

These comments suggest that the two epidemiological studies cited above exclusively rely on a collection of subjective symptoms indicative of non-specific soreness and discomfort, rather than objective measurement of inflammation and tissue pathology. This criticism also applies to virtually all the existing epidemiological studies that examined epicondylitis since they used a similar set of criteria to diagnose this MSD. As a result, the commenters believe OSHA has not made a sufficient case that true epicondylitis (as well as tenosynovitis) is associated with workplace exposure to biomechanical risk factors.

OSHA disagrees with the notion that evidence of tissue pathology among exposed workers is required to infer a causal relationship between exposure to physical risk factors in the workplace and epicondylitis. The studies of Luopajarvi *et al.*(Ex. 26–56) and Kurppa *et al.*(Ex. 26–53) were directed by the Institute of Occupational Health in Helsinki, Finland, which developed systematic methods for screening and diagnosing a number of occupational neck, shoulder, and upper limb disorders, including lateral and medial epicondylitis. The examination procedures and diagnostic criteria have been published in the peer-reviewed literature (Waris *et al.*1979, Ex. 26–1218) and they were devised by a team of clinicians comprised of occupational physicians, an orthopedist, physiologist, and ergonomist. The diagnosis for lateral epicondylitis (the most common form of epicondylitis) is not simply self-reported elbow soreness. The tenderness must be localized over the lateral epicondyle and there must be pain associated with resisted extension of the wrist and fingers (resistence test). In the Finnish studies, these signs were evaluated by either physicians specializing in occupational health or a trained physiotherapist. Other potential causes unrelated to physical work factors, such as fractures, acute trauma, recreational injuries, infection, arthritis, pre-existing neurological diseases, etc., were assessed and screened out through medical histories and personal interview.

The Finnish criteria are consistent with procedures for the assessment, diagnosis, and management of elbow complaints recommended by the American College of Occupational and Environmental Medicine (ACOEM, Ex. 502–240). These guidelines do not call for tissue evidence of inflammation and pathology in diagnosing lateral epicondylitis, but rather depend on expert evaluation of unique signs and symptoms by a trained clinician upon physical examination. The food packers in the cross-sectional investigation by Luopajarvi *et al.* (Ex. 26–56) were examined by a physiotherapist specially trained at the Finnish Institute of Occupational Health. The meat processors in the prospective Kurppa *et al.*(Ex. 26–53) study were primarily diagnosed by occupational physicians at the plant using the criteria developed by the Finnish Institute. The same diagnostic approach was also used by the other key epidemiological studies that found an association between work-related factors and epicondylitis (Chiang *et al.*1993, Ex. 26–1117; Moore and Garg 1994, Ex. 26–1364; Bovenzi *et al.*1991, Ex. 26–1433). More specialized diagnostic tools, such as imaging and electromyography, are only advised if a prudent course of elbow/forearm rest and pain relief do not adequately correct the disorder or more serious complications are suspected (*e.g.* fracture, osteomyelitis, neurological damage).

OSHA finds that the case definition of epicondylitis used by the epidemiological investigators is appropriate for diagnosing this MSD. The evaluations were administered by trained clinicians using specific and standardized criteria that are uniformly accepted by the medical community. This was confirmed by testimony from numerous physicians during the hearings (AFL–CIO, Ex. 500–218). The published clinical guidelines and testimony from the record cited above make clear that the criteria of localized tenderness at a critical bone-tendon junction (MSD symptom) combined with pain upon palpation and extension/flexion of the wrist during physical examination (positive physical finding) are sufficient for the proper diagnosis of epicondylitis without the need for further ''objective evidence of true inflammation.''

Biomechanical Evidence

There is a very limited amount of specific study information available in the Health Effects Appendices for the proposed rule (Ex. 27–1) that measure the biomechanical forces at the muscle-tendon units of the elbow. However, as discussed in the Health Effects Appendix, there is some evidence suggesting that tensile loading on the extensor carpi radialis brevis (ECRB) muscle created by muscular action in combination with elbow extension and pronation/supination of the forearm causes a compressive force at the tendon, ligament, and radial head of the elbow. Prolonged contact pressure and/or repeated loading is likely to produce fraying of the ECRB. The resulting cycle of damage/repair leads to clinical and pathological manifestations of lateral epicondylitis.

Conclusion

The 1997 NIOSH report concluded the following with regard to the relationship between work-related physical risk factors and epicondylitis:

> There is strong evidence for a relationship between exposure to a combination of risk factors (e.g. force and repetition, force and posture) and epicondylitis. Based on a review of the epidemiologic studies, especially those with some quantitative evaluation of the risk factors, the evidence is clear that an exposure to a combination of exposures, especially at higher levels (as can be seen in, for example, meatpacking or construction work) increases the risk for epicondylitis (Ex. 26–1, Emphasis in original).

OSHA agrees with NIOSH that there is a reasonably strong body of evidence showing a relationship between exposure to combinations of biomechanical risk factors, usually forceful exertion/repetitive motion or forceful exertion/repetitive motion/awkward posture, and an increased risk of epicondylitis. This evidence emanates from the consistently positive associations in epidemiological studies of workers from several different industry sectors, especially those investigations that rely on expert verification of injury and objective determination of exposure. The epidemiological evidence is supported by the large number of clinical reports and investigations in the medical and sports literature. There is biological plausibility that exposure to combinations of risk factors can lead to epicondylitis since forceful and repetitive exertion of the forearm muscles and tendons are also consistent with the pathophysiology of epicondylitis. As described in the NIOSH review of the epidemiological evidence, there is less evidence that exposure to repetition or awkward posture *alone,* is associated with an increased risk of epicondylitis. OSHA concludes that workers who perform job tasks requiring repeated forceful movements, especially flexion, pronation, or supination with the arm extended, are at increased risk of developing epicondylitis.

Tendinitis of the Hand and Wrist

Most cases of tendinitis of the hand and wrist originate as inflammation of the synovial sheath that provides protection for the tendons. This condition is known as tenosynovitis. Inflammation may occur in the flexor tendons on the palmar aspect of the wrist, extensor tendons on the back of the wrist, or the small separate collection of extensor tendons that controls the extension of the thumb. There are a number of pathophysiological outcomes that result from irritation of the tendons. If the sheath becomes aggravated, excessive synovial fluid can build up resulting in swelling along the affected tendon. Sometimes irritation can occur just proximal to the tendon sheath where there is no synovial fluid. This causes a dry rubbing of the tendon called peritendinitis crepitans, so named because of the discernable creaking sensation. There is also a type of tenosynovitis, known as stenosing tenovanginitis, caused by a constriction of the tendons at the mouth of the sheath. If this constriction occurs on the radial aspect of the wrist involving the extensor tendons to the thumb, it is known as De Quervain's syndrome. If the site of injury is the flexor tendons to the fingers, it is known as trigger finger. Stenosing tenovanginitis is thought to be the result of compression caused by the thickening of the retinaculum (band of ligaments around the wrist holding the tendons in place) leading to tendon entrapment.

One publication in the record described the symptoms and prognosis of patients that have trigger finger or thumb:

> The classic picture [of trigger finger/thumb patients] is painful ''locking'' of the digit in flexion whereby the patient has difficulty extending the proximal interphalangeal joint. Extension can be accomplished passively using the other hand and produces a moderate amount of discomfort and a palpable painful ''snap.'' * * * The prognosis is excellent for a complete recovery barring the occurrence of multiple trigger fingers and/or significant osteoarthritis * * *. In these cases the course is usually prolonged. Patients tend to question their ability to return to their old jobs and, on occasion, any job. In general, workers should be able to return to heavy work, although it may take somewhat longer after surgery because of a tender palmar scar. [Ex. 38–453, pp. 105–106]

Epidemiological Evidence

NIOSH (1997, Ex. 26–1) reviewed seven cross-sectional studies and one cohort study that addressed workplace risk factors and MSDs that specifically addressed hand/wrist tendinitis. Table V–4 summarizes some key aspects of these investigations. In these studies, tendinitis cases were identified primarily by physical examination, which usually included localized pain/tenderness at the tendons upon palpation during movement of the hand/wrist. However, diagnostic criteria varied across studies depending on the types of tenosynovitis of interest. For example, some investigations required the presence of swelling along the tendons of the wrist and/or signs of crepitation. In some cases, a positive Finkelstein's test was used to diagnose DeQuervain's syndrome. Because of the differences in case definition, it is difficult to compare prevalence rates from different studies, although measures of relative risk should be less affected as long as case definitions were non-differentially applied to exposed and unexposed groups (NIOSH 1997, Ex. 26–1).

Exposure assessment was generally restricted to grouping workers in exposed and unexposed categories based on the existence of a combination of excessive force, repetitive motion, and awkward posture. In these studies, most exposed workers were subjected to the combined effect of at least two risk factors. Five studies relied on direct observation of job tasks and expert judgment to determine exposure (Armstrong et. al. 1987, Ex. 26–48; Luopajarvi et. al. 1979, Ex. 26–56; Bystrom et. al. 1995, Ex. 26–897; Kuorinka et. al. 1979, Ex. 26–639; Kurppa et. al. 1991, Ex. 26–53). One of these studies quantified force and repetitiveness for a subset of workers performing different jobs and grouped them according to these measurements (Armstrong et. al. 1987, Ex. 26–48). Three studies used less reliable methods of assessing exposure such as self-reports or general knowledge of job tasks.

TABLE V–4.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING HAND/WRIST TENDINITIS

Study	Job type studied	Physical factors	Exposure basis	Physical exam	Risk measure (95% CI)[1]
Kurppa (1991) Ex. 26–53	Meat processing	F/R/P?	Observation	Yes	IR=14–38.5* (11–56)
Armstrong (1987) Ex. 26–48	Manufacturing	F/R/P?	Measurement EMG.	Yes	PRR=4.8–17* (2.3–126)
Moore (2000) Ex. 500–71–41	Pork processing F/R?/P.	F/R?P	Observation	Yes	PRR=7.0*
Luopajarvi (1979) Ex. 26–56	Food production	F/R/P	Observation	Yes	PRR=4.1* (2.6–6.5)
Latko (1999) Ex. 38–123	Manufacturing	R/F/P?	Measurement, cycle time.	Yes	OR=3.2* (1.3–8.3)
Bystrom (1995) Ex. 26–897	Auto assembly	F/R/P	Forearm load, wrist flex.	Yes	PRR=2.5* (1.0–6.2)
Kuorinka (1979) Ex. 26–639	Scissor production	F?/R/P	Cycle time, wrist flex.	Yes	PRR=1.4 (0.8–2.5)
Amano (1988) Cited in Ex. 26–1	Shoe assembly	F?/R/P	Job title	Yes	PRR=3.7–6.2* (2.7–14)
Roto (1984) Ex. 26–666	Meat cutting	F/R/P?	Job title	Yes	PRR=3.1* (1.4–6.7)
McCormack (1990) Ex. 26–1334	Textile	F/R/P?	Job title	Yes	PRR=0.4–3.0* (1.4–6.4)

F=forceful exertions; R=repetitive motion; P=awkward posture; ?=presence of risk factor unclear.
IR=incidence rate; PRR=prevalence ratios;
*=p<0.05.
[1] 95% confidence interval expressed for the upper end of the risk measure range.

Of the five studies with the most reliably documented exposure, four reported statistically significant increases in the prevalence of hand/wrist tendinitis in workers exposed to physical risk factors (Armstrong *et al.*1987, Ex. 26–48; Luopajarvi *et al.*1979, Ex. 26–56; Bystrom *et al.*1995, Ex. 26–897; Kurppa *et al.*1991, Ex.26–53). In their review, NIOSH (1997, Ex. 27–1) chose the prevalence ratio (PR) to represent an estimate of relative risk rather than the more commonly reported OR for hand/wrist tendinitis, because the OR can overestimate relative risk when prevalence rates among unexposed groups are high. A few of the studies on work-related tendinitis reported prevalence rates greater than 25 percent in exposed groups and greater than 10 percent in unexposed groups.

The Armstrong *et al.*(Ex. 26–48) study was able to divide industrial workers at seven manufacturing plants into a low force/low repetition group, a high force/low repetition group, low force/high repetition group, and a high force/high repetition group based on EMG measurements and observed cycle times. They found exposure-related increases in the prevalence of tenosynovitis (including stenosing tenovanginitis). The high-force/low-repetition group and low-force/high-repetition group had PRs of 4.8 (95% CI 0.6–39.7) and 5.5 (95% CI 0.7–46.3), respectively, compared to the low-force/low-repetition group, while the high-force/high-repetition group had a PR of 17.0 (2.3–126.2). The Kourinka *et al.*(Ex. 26–639) study of mostly female scissors makers found a non-statistically significant increase in the prevalence of tenosynovitis (including peritendinitis) with an increase in the number of pieces handled per year. The PR was 1.4 (95% CI 0.8–2.5) among all exposed workers compared to a referent group of department store assistants. In this study, it is unclear whether cashiers (a potentially exposed group) were included in the referent population; if so, this would tend to diminish the association between exposure and outcome. The results of these two studies suggest the presence of a positive exposure-response relationship between exposure to biomechanical risk factors and the risk of hand/wrist tendinitis.

Luopajarvi *et al.*(Ex. 26–56) found a significant increase in PR (4.1; 95% CI 2.6–6.5) of tenosynovitis (including peritendinitis) among female assembly line food packers compared to department store assistants (cashiers excluded from the unexposed group). Bystrom *et al.*(Ex. 26–897) found a significant increase in PR (2.5; 95% CI 1.0–6.2) of DeQuervain's syndrome among automobile assembly line workers compared to randomly selected subjects (adjusted for potential confounders) from the general population. The prospective cohort study by Kurppa *et al.*(Ex. 26–53) found a significant increase in the incidence of tenosynovitis (including peritendinitis and DeQuervain's syndrome) over a 31-month period in meat processing workers (primarily cutters and packers) engaged in strenuous compared to non-strenuous work (primarily office work). They reported relative risks ranging from 14.0 to 38.5 for different job categories, but these may be overestimated since recurrences of tendinitis were counted as new cases and case ascertainment was different for the exposed and referent groups. This study does provide evidence of a temporal relationship between exposure to physical work factors and development of tendinitis. Confounders, such as gender and age, were adequately controlled for in the key studies.

Two studies that address physical work factors and tenosynovitis were submitted to the OSHA docket following publication of the proposal (Moore 2000, Ex. 26–1364; Latko *et al.*1999, Ex. 38–123). Summary results of these studies also appear in Table V–4. Moore (Ex. 500–71–41) found a significant increase in the prevalence of stenosing tenovanginitis as a result of jobs requiring repetitive and forceful use of hand tools compared to jobs without exposure to this risk factor. Latko *et al.*(Ex. 38–123) reported a significant linear trend between repetitive work and hand/wrist tendinitis ($p<0.01$) in a cross-sectional study of 438 manufacturing workers. Worker exposure to physical work factors were directly observed and measured in this study and tendinitis cases were confirmed through physical examination by an occupational physician in both the Moore and Latko studies.

Biomechanical Evidence

Static and dynamic biomechanical models of the wrist have been used to estimate tensile, normal, and frictional forces in finger flexor tendons during static and dynamic work involving the hand (Exs. 26–582, 38–418). Pinching and gripping activities produce tensile forces on the tendons that are three to four times the normal force on the fingers. Static biomechanical models predict that additional compressive and frictional forces are exerted on the tendon when the wrist deviates from a neutral position as the tendon sheaths slide against the bones of the carpal tunnel and flexor retinaculum. These predictions have been confirmed by cadaver studies of forces on the tendons, ligaments, and bones of the hand. A laboratory study showed that peak tensile forces in the flexor tendons were approximately doubled during a simulated caulking task with a straight wrist and approximately tripled during the same task with a flexed wrist (Moore *et al.*1991, Ex. 26–183).

When a dynamic component is added to the biomechanical model, it is predicted that tensile and normal forces on the finger flexor tendons increase rapidly during rapid wrist accelerations. These predictions are supported by a preliminary surveillance study that found wrist acceleration to be substantially higher in jobs with a high rate of upper extremity cumulative trauma disorders (Marras and Shoenmarklin 1993, Ex. 26–172). The biomechanical and laboratory evidence provides additional support that biomechanical risk factors, such as sustained/repetitive forceful exertions and flexion/extension of the wrist, can create internal strain on tendons that could result in injury consistent with tenosynovitis.

Conclusion

The 1997 NIOSH report concluded the following with regard to the relationship between work-related physical risk factors and hand/wrist tendinitis: ''There is strong evidence that job tasks that require a combination of risk factors (*e.g.*, highly repetitious, forceful hand/wrist exertions) increase risk for hand/wrist tendinitis'' (Ex. 26–1). OSHA also finds clear epidemiologic evidence of a relationship between a combination of physical risk factors, such as repetitive and forceful hand activities with a flexed wrist, and tenosynovitis. This evidence is from the consistently positive associations in the epidemiological studies described above. There are also laboratory studies that confirm that hand-intensive work, particularly with a bent wrist, produces significant load and strain on the flexor tendons. The biomechanical evidence is consistent with the pathophysiology of tenosynovitis where sustained and elevated internal force on the tendon sheaths can be expected to cause synovial fluid accumulation, thickening of the sheath, tendon entrapment, and other physiological responses that lead to clinical symptoms associated with this MSD. These biomechanical studies demonstrate that the increased risk of hand/wrist tendinitis seen among workers exposed to forceful and repetitive hand activities is biologically plausible and consistent with the epidemiologic evidence. OSHA therefore concludes that workers exposed to these risk factors are at increased risk of developing hand/wrist tendinitis.

Carpal Tunnel Syndrome (CTS)

CTS is a disorder that results from compression of the median nerve at the point of passage through the carpal tunnel, the narrow opening in the hand consisting of carpal bones of the wrist on the bottom and the carpal ligament on top. The carpal tunnel is a relatively ''tight'' compartment filled with flexor tendons as well as the median nerve that serve to move and enervate the fingers. Forceful contraction of the flexor tendons in the fingers that occur during repetitive hand tasks increase the pressure within the carpal tunnel (Ex. 38–444). Chronic intracarpal pressure limits the vascular flow to the median nerve and surrounding tissue leading to swelling of the tendon sheath. The epineural edema leads to compression of the median nerve against the carpal ligament. The ensuing loss of nerve function initially results in painful tingling and numbness in the hand. After several years, eventually the tendon tissue can become fibrotic and result in muscle weakness, reduced grip strength and loss of finger movement. CTS is often accompanied by tenosynovitis, which is not surprising given their common pathophysiology. CTS is a disabling condition that has frequently required surgery to provide the affected individual with relief. For example, in Washington State in 1996, more than one-third of all CTS workers' compensation claimants required surgery as part of their treatment (Ex. 500–71–47, P. 12). Histologic studies of flexor tendon sheaths sampled during carpal tunnel surgery support the above model since vascular changes consistent with ischemia and tissue edema are commonly observed (Ex. 26–838).

National and international surveillance data have consistently indicated that the highest rates of CTS occur in occupations and job tasks (meat processing, assembly line work, intensive use of hand and power tools, etc.) requiring repeated wrist movements, forceful exertions, and wrist bending or other stressful postures.

Epidemiological Evidence

NIOSH reviewed 30 epidemiological studies that addressed workplace risk factors and CTS. Exposed workers in theses studies were usually engaged in job activities involving forceful and repetitive hand/finger or wrist movements and therefore were concurrently subjected to a combination of physical factors. These studies are summarized in Table V–5. Thirteen studies used physical examination or electrophysical indicators to diagnose CTS as well as direct observation or measurement of exposure to risk factors during job activities. The remaining studies either relied on symptom questionnaires to determine health outcomes or self reports and job title descriptions to evaluate exposures. CTS was solely determined by the presence of numbness, pain or tingling in the fingers enervated by the median nerve, and a positive Tinel's or Phalen's test (symptoms triggered upon wrist flexion and palpation) in about half the studies. Nerve conduction (NC) tests were not used in defining cases in these studies. In the other half of the studies, abnormal median nerve conduction was required in addition to symptomatology to diagnose CTS. Since normal NC was often defined and measured differently in various laboratories, CTS case definition is unlikely to be uniform across studies. Several investigations quantitatively estimated force, either from EMG measurements or based on weights of tools or other handled parts, and recorded job task observations. Repetitive hand/wrist movements were sometimes quantitatively measured and categorized based on task frequency, quantity of work performed in a specified time, or ratio of work time to recovery time.

Of the 13 studies (eleven cross-sectional and two case control) that relied on both objective determination of exposure and medical diagnosis of CTS, 10 reported finding statistically significant associations between CTS and exposure to biomechanical risk factors. The reported ORs ranged from 1.1 to 21.3. Some cross-sectional studies provided evidence of an exposure-response relationship with respect to CTS and exposure to force and repetition. Silverstein *et al.*studied 652 workers in 39 jobs from 7 different plants (Silverstein *et al.*1987, Ex. 26–34). Jobs were grouped into high and low repetitiveness and force categories based on cycle time and EMG measurements, respectively. The OR for CTS (defined by physical tests/symptoms) in highly repetitive jobs compared to low repetitive jobs, irrespective of force, was 5.5 ($p<0.05$) in a multiple logistic model that included age, gender, plant site and years on the job. The corresponding OR for high-force jobs, irrespective of repetitiveness, was 2.9 ($p>0.05$) and the OR for combined exposures to high repetition and force was 15.5 ($p<0.05$).

TABLE V–5.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING CARPAL TUNNEL SYNDROME

Study	Job type studied	Physical factors	Exposure basis	Diagnosis	Risk measure (95% CI)[1]
Bovenzi (1991) Ex. 26–1433	Forestry	V	Measurement	Physical exam	OR=21* (NR)
Roquelaure (1997) Ex. 38–396	Manufacturing	F/R/P	Measurement	Physical exam+NC	OR=9.0* (2.4–33.4)
Silverstein (1987) Ex. 26–34	Manufacturing	V/F/R/P	Measurement	Physical exam	OR=1.8–15.5* (1.7–142)
Chatterjee (1992) Ex. 26–942	Rock drilling	V	Measurement	Physical exam+NC	OR=10.9* (1.0–524)
Osorio (1994) Ex. 26–807	Supermarket	F/R/P?	Observation	Physical exam+NC	OR=6.7–8.3* (2.6–26.4)
Barnhart (1991) Ex. 26–1216	Ski manufacture	F?/R/P	Measurement	Physical exam+NC	OR=1.9–40* (1.0–15.8)
Frost (1998) Ex. 38–198	Slaughter house	F/R/P	Measurements	Physical exam+NC	OR=4.2* (1.8–10.1)
Bovenzi (1994) Ex. 26–774	Stone drilling	V	Measurement	Physical exam	OR=e.4* (1.4–8.3)
Baron (1991) Ex. 26–697	Grocery checking	F/R/P	Measurement	Physical exam	OR=3.7 (0.7–16.7)
Moore (1994) Ex. 26–1364	Meat processing	F/R/P	Measurement	Physical exam+NC	OR=2.8 (0.2–36.7)
Chiang (1990) Ex. 26–1118	Frozen Food Packing.	F?/R/P?	Measurement	Physical exam+NC	OR=1.9–11.7* (2.9–46.6)
Chiang (1993) Ex. 26–1117	Fish processing	F/R/P?	Cycle time, EMG	Physical exam	OR=1.1–1.8* (1.1–2.9)
Stetson (1993) Ex. 26–1221	General industry	F/R/P	Checklist	NC only	NR*
Latko (1999) Ex. 38–123	Manufacturing	F/R/P?	Measurement	Physical exam+NC	OR=2.3–3.1 (0.9–10.9)
Armstrong (1979) Ex. 26–348	Sewing machine use	F/R/P	EMG, flexion	Physical exam	OR=1.1–2.0* (1.6–2.5)
Nathan (1988) Ex. 26–990	Multiple industries	F/R/P	Observation	NC only	PRR=1.0–2.0* (1.1–3.4)
Nathan (1992) Ex. 26–989	Multiple industries	F/R/P	Observation	NC, symptoms	PRR=1.0–1.5 (1.0–2.2)
Canon (1981) Ex. 26–1212	Aircraft plant	V/R	Hand tool measurement.	Workers' comp	OR=2.1–7.0* (3.0–17)
English (1995) Ex. 26–848	CTS case/control	F/R/P	Questionnaire	Physical exam	OR=0.4–1.8* (1.2–2.8)

TABLE V–5.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING CARPAL TUNNEL SYNDROME—Continued

Study	Job type studied	Physical factors	Exposure basis	Diagnosis	Risk measure (95% CI)[1]
Feldman (1987) Ex. 26–1210	Electronics plant	F?/R/P	Cycle time flexion	Questionnaire	OR=2.3* (1.4–4.5)
Koskimies (1990) Ex. 26–973	Forestry	V	Job title	Physical exam+NC	NR*
McCormack (1990) Ex. 26–1334	Textile	F/R/P?	Job title	Physical exam	OR=0.4–0.9 (0.3–2.9)
Morgenstern (1991) Ex. 26–1493	Grocery cashiers	F?/R/P	Job title	Questionnaire	OR=1.9 (0.9–3.8)
Punnett (1985) Ex. 26–995	Garment	F?/R/P?	Job title	Physical exam	OR=2.7* (1.2–7.6)
Schottland (1991) Ex. 26–1001	Poultry processing	F/R/P	Job title	NC only	OR=1.9–2.9* (1.1–7.9)
Weislander (1989) Ex. 26–1027	CTS case/control	V/F/R/P?	Questionnaire	Physical exam+NC	OR=1.8–3.3* (1.6–6.8)
Liss (1995) Ex. 26–55	Dental hygienist	F?/R/P	Questionnaire	Questionnaire	OR=3.7* (1.1–11.9)
DeKrom (1990) Ex. 500–41–28	CTS case/control	F/R?/P	Questionnaire	Physical exam+NC	OR=5.4–8.7* (3.1–24.1)
Tanaka (1997) Ex. 26–1185	Household survey	V/P	Questionnaire	Questionnaire	OR=1.8–5.9* (3.4–10.2)
Farkkila (1988) Ex. 26–947	Chair saw use	V	Questionnaire	Physical exam+NC	NR*
SHARP (1993) Ex. 500–41–116	Poultry processing	F/R	Measurement	Questionnaire	NR* (p< 0.0004)
Rosecrance (1994) Ex. 38–203	Newspaper work	F/P/R/ (pinch)	Questionnaire	Physical exam	NR*
Rossignol (1997) Ex. 500–205–24	Manual labor	F/R?/P?	Questionnaire	Surgery for CTS	OR=4.1* (1.5–3.2)
LeClerc (1998) Ex. 500–41–85	Assembly line	R/P?	Questionnaire	Physical exam+NC	OR=3.1–6.6*
Atroshi (1999) Ex. 38–181	General Population	F/P/R/V	Questionnaire	Physical exam+NC	OR=1.0–3.0* (1.4–6.8)
Gorsche (1999) Ex. 500–121–23	Meat packing	V	Questionnaire	Physical exam	NR
Katz (1998) Ex. 38–393	CTS case control	F/R/P	Questionnaire	Physical exam	NR
Kerns (2000) Ex. 500–71–34	Pork processing	F/R/P	Job title	NC only	NR

F=forceful exertions; R=repetitive motion; P=awkward posture; V=vibration; ?=presence of risk factor unclear.
NCV=nerve conduction; IR=incidence rate; OR=odds ratio; PRR=prevalence rate ratio; NR=not reported.
*=p<0.05.
[1] 95% confidence interval expressed for the upper end of the risk measure range.

Chiang *et al.*studied 207 workers from 8 fish processing factories in Taiwan (Chiang *et al.*1993, Ex. 26–1117). Jobs were divided into three groups based on level of repetitiveness and force using cycle times (upper arm movements, not just wrist) and EMG of the forearm flexor muscles. There was a statistically significant trend in prevalence of CTS (defined by physical tests/symptoms) with exposure from low force/repetition, high force *or* high repetition, and high force/repetition. Force alone, but not repetitiveness, significantly predicted CTS (OR=1.8; 95% CI 1.1–2.9).

Several other epidemiological investigations found physical risk factors to be significantly associated with prevalence of CTS. In another Chiang *et al.*study of 207 workers from 2 frozen food processing plants, job tasks were grouped by low and high repetitiveness based on wrist movement cycle time (Chiang *et al.*1990, Ex. 26–1118). Statistical modeling that included gender, age, and cold temperatures resulted in an OR of 1.9 ($p<0.05$) for CTS (defined by physical tests/symptoms/NC studies). This study stressed the association between CTS and repetitive movements, although some forceful hand/wrist exertion probably existed in the study group.

Stetson *et al.*studied median NC on 103 automotive workers with symptoms consistent with CTS compared with 137 asymptomatic automotive workers and an unexposed group of 105 administrative and professional workers (Stetson *et al.*1993, Ex. 26–1221). Repetitiveness was evaluated by cycle times, hand/wrist grip forces were estimated based on weights of handled tools and parts, and wrist deviation was judged from videotape analysis. Both symptomatic and asymptomatic workers had significantly lower median sensory amplitudes and significantly longer distal latency times than the referent group. The same NC trends were found between automotive workers in jobs requiring grip force greater than 6 pounds compared to those requiring less than 6 pounds. This grip force variable probably combines forceful exertion with wrist deviation. It was not possible to adequately compare repetitive and non-repetitive work since this risk factor was present in almost the entire study group.

Barnhardt *et al.*found ski manufacturing workers with highly repetitive job tasks had a statistically elevated OR of 4.0 (95% CI 1.0–15.8) for CTS (defined by physical tests/NC studies) compared to those workers engaged in non-repetitive tasks (Barnhardt *et al.*1991, Ex. 26–1216). Exposure was evaluated by observational analysis and included repetitive jobs with sustained flexion, extension, or ulnar deviation of the wrists by 45 degrees. The participation rate for this study was lower (less than 70 percent) than most of the other investigations. Armstrong and Chaffin reported that CTS (defined by physical tests/symptoms) was significantly associated (OR=2.0; 95% CI 1.6–2.5) with pinch force exertion (combination of force and deviated wrist posture) in female sewing machine operators (Armstrong and Chaffin 1979, Ex. 26–348). Because of the case-control study design, it is not clear whether deviated postures contributed to the development of CTS or whether the CTS symptoms led to the use of abnormal postures during work.

Four of the studies addressed CTS and manual work involving vibrating power tools. A case control study by Chatterjee *et al.*found a significant difference (OR=10.9; 95% CI 1.0–524) in the prevalence of CTS cases (defined by NC studies/symptoms) in rock drillers compared with controls (Chatterjee *et al.*1982, Ex. 26–942). The rock drillers were exposed to vibration frequencies between 31.5 and 62 Hertz. The highest relative risks (OR=21.3; p<0.002) for CTS (defined by physical tests/ symptoms) were found in forestry workers using chain saws compared to maintenance workers who did not use power tools (Bovenzi *et al.*1991, Ex. 26–1433). Differences in ambient temperatures (potential confounder) between outdoor (chain saw operators) and indoor work (maintenance workers) may have contributed to the results. Koskimies *et al.*reported significant correlations between reductions in NC velocities in the median and ulnar nerves and number of years of vibration exposure in forestry workers who used chain saws greater than 500 hours in the previous 3 years (Koskimies *et al.*1990, Ex. 26–973). The prevalence of CTS (defined by physical tests/symptoms) in these workers was 20 percent. In another study, Bovenzi *et al.*reported an OR of 3.4 (95% CI 1.4–8.3) for CTS (defined by NC studies/symptoms) among stone quarry drillers/carvers exposed to hand-transmitted vibration when compared to polishers who performed manual operations and were not exposed to vibration (Bovenzi et al., 1994, 26–774). In these four studies, flexor tendons and the median nerve of the hand were probably subjected to a considerable degree of forceful exertion as well as mechanical injury during use of these power tools. Vibration can also cause direct damage to the digital arteries leading to sensory loss and numbness.

There were three studies that did not find statistically significant association between CTS and exposure to physical risk factors, even though each reported substantially raised ORs. Moore and Garg found an OR of 2.8 (95% CI 0.2–36.7) for CTS (defined by NC studies/ symptoms) among pork processing workers in hazardous jobs compared to safe jobs (Moore and Garg 1994, Ex. 26–1033). Jobs were categorized based on videotape analysis for estimates of force, repetitition and awkward postures. The possible presence of a healthy worker effect (most workers were laid off in the year prior to the study) and the short latency period (8–32 months) limits confidence in the relative risk estimate.

An OR of 6.7 (95% CI 0.8–52.9) for CTS (defined by NC studies/symptoms) was reported in a study of supermarket workers rated for high versus low exposure to repetitive and forceful wrist motions as judged by an ergonomist and industrial hygienist (Osorio *et al.*1994, Ex. 26–807). However, the entire study consisted of only 56 workers grouped into 3 categories for analysis limiting the power of the study to find a statistically significant association. Baron et. al. (Ex. 26–697) also studied CTS (defined by physical tests/ symptoms) in 124 grocery store checkers and reported an OR of 3.7 (95% CI 0.7–16.7) compared to 157 non-checkers. Physical examinations were not done on all workers and the relative risk measure was based on responses to a standardized questionnaire. The exposure level for checkers was characterized as having low peak force and a medium level of repetition; therefore, the intensity of exposure to physical risk factors was less than that among workers examined in other studies.

Almost all studies controlled for the obvious confounders of age, gender, and predisposing medical conditions by selection of an appropriate referent population, stratification, or use of a multiple logistic regression model. Many of the cross-sectional studies either excluded workers with pre-existing CTS prior to employment or excluded recently hired workers from the study. Therefore, it is unlikely that the reported associations between CTS and exposure to biomechanical risk factors reflected preferential employment of those with CTS (*i.e.,* the requirements for entry into the cohort made it likely that exposure preceded the onset of CTS).

NIOSH (1997, Ex. 27–1) concluded that there was epidemiological evidence of a positive association between CTS and highly repetitive work, either alone or in combination with other risk factors. They also found evidence of positive associations between forceful work and work involving hand/wrist vibration and CTS. However, NIOSH concluded there was insufficient evidence of an association between CTS and exposure to extreme postures alone because of individual variability in work methods and difficulties in measuring postural characteristics. NIOSH did recognize that there was strong evidence that exposure to a combination of physical risk factors along with non-neutral wrist postures was related to the onset of CTS.

A large number of studies that addressed physical work factors and CTS were submitted into the OSHA docket following publication of the proposal; those that OSHA found to be of adequate study design are included in Table V–5 (Frost *et al.*1998, Ex. 38–198; Roquelaure *et al.*1997, Ex. 500–41–111; Latko *et al.*1999, Ex. 38–123; Rossignol *et al.*1997, Ex. 502–420; Leclerc *et al.*1998, Ex. 500–41–85; Atroshi *et al.*1999, Ex. 38–181; Gorsche *et al.*1999, Ex. 500-121–23; Kearns *et al.*2000, Ex. 500–71–34; Katz *et al.*1998, Ex. 38–393). All but three of these studies (Ex. 500–121–23; Ex. 500–71–34; Ex. 38–393) found significantly increased prevalence of CTS among workers exposed to physical risk factors. The three studies that did not find a statistically significant association did not rely on independent assessment or observation of exposure to physical work factors, but instead used job titles or self-reported survey information to infer exposure. One of these studies, Gorsche *et al.*(Ex. 500–121–23), found an increased prevalence and incidence of CTS in a cross-sectional and longitudinal study of meat packers but it was not statistically significant. Kearns *et al.*(Ex. 500–71–34), who ascertained cases only by nerve conduction studies and did not rely on symptoms or clinical evaluation to diagnose CTS, also failed to find a statistically significant association. Katz *et al.*(Ex. 38–393) studied factors associated with long-term disability rather than the development of CTS.

In contrast, three studies that did measure or observe exposures and used a combination of symptoms, physical tests, and nerve conduction velocity measurements to diagnose CTS found strong associations with exposure to repetition and/or force (Exs. 38–198, 500–41–111, 38–123). Another study, the SHARP study (Ex. 500–41–116) of poultry processing workers summarized in the hand/wrist tendinitis section above, found that the number of forceful exertions per hour was significantly predictive of CTS (p=0.004).

Many studies of CTS contained in the rulemaking docket are not included in Table V–5 either because it was questionable whether exposure to physical risk factors occurred or because the study did not address the relationship between physical risk factors and CTS (Nathan and Keniston 1993, Ex. 351–14; Stallings *et al.*1997, Ex 351–20; Franzblau *et al.*1994, Ex. 38–175; Nordstrom *et al.*1988, Ex. 500–25–9; Zetterberg and Ofverholm 1999, Ex. 500–121–78). Other studies were not included on OSHA's summary table because they used a flawed study design or a flawed statistical analysis to examine the relationship between exposure to biomechanical risk factors and CTS (Malchaive *et al.*1996, Ex. 500–

66–5; Homan *et al.*1999, Ex. 38–172; Olafsdotti *et al.* 2000, Ex 38–288.

One of the above studies is among several papers published by Dr. Peter Nathan and colleagues, which were based on two group of workers whom they have followed prospectively (Ex. 26–990; Ex. 26–988; Ex. 26–989; Ex. 26–1294; Ex. 26–517; Ex. 38–437; Ex. 38–13; Ex. 351–14). Because of the importance of these studies to the ergonomics rulemaking, they are addressed in detail here. In one of the earlier studies (Nathan *et al.*1988, Ex. 26–990), nerve conduction was assessed on 471 randomly chosen individuals from four industries (steel mill, meat/food packaging, electronics, and plastics manufacturing). The group was divided into the following exposure categories:

• Group 1, very low force, low repetition;
• Group 2, low force, very high repetition;
• Group 3, moderate force, moderate repetition;
• Group 4, high force, moderate repetition; and
• Group 5, high force, high repetition.

No significant difference in median nerve sensory latency values was found between Group 1 and Group 2, which differed primarily by the amount of repetition exposure. There was a statistically significantly higher number of subjects with median nerve slowing in Group 5 compared to Group 1, but not when compared to Groups 2, 3, or 4. When individual hands were used to base calculations rather than number of individuals, only Group 3 showed a significantly higher prevalence of median nerve conduction slowing. When prevalence ratios were calculated, Groups 3, 4, and 5 had significantly higher PRs compared to Group 1.

This same group of workers was followed up for five years in a 1992 study (Ex. 26–988) and eleven years in a 1998 study (Ex. 38–13). The study used hands, rather than individuals, as the basis for analysis. The authors stated that they found no significant difference in the prevalence of median nerve slowing among any of the exposure groups. The authors claimed to have confirmed this finding in a second combined cohort of Japanese and American industrial workers (Ex. 38–437) as well as validated their exposure categories (Ex. 26–1294). They went on to show that slowing of nerve conduction was significantly associated with obesity (Ex. 26–989), body mass index (Ex. 26–517), wrist depth/width and a number of other non-occupational risk factors (Ex. 351–14).

However, their research has a number of flaws in the study design, analysis and interpretation of the results, which call their conclusions into doubt. Chief among these is the failure to adequately justify and validate their grouping and rank order of occupational hand use. This provides multiple opportunities for exposure misclassification and will tend to underestimate the association of exposure with health outcome. This aspect of the study has been criticized by several experts (Ex. 26–1010; Ex. 26–952; Tr. 1000). Despite this potential for misclassification, there was a significant increase in prevalence between the lowest (Group I) and higher exposure groups combined (Groups III, IV, and V) in the cross-sectional study (Ex. 26–990). Others have also concluded that, methodological shortcomings aside, the articles by Nathan *et al.*demonstrate a positive exposure-response relationship between ‘‘occupational hand activity’’ and slowed conduction of the median nerve (Tr. 1519–1522; Tr. 9862). Others have testified that alternative exposure grouping of the data resulting in less exposure misclassification would result in a clear exposure-response relationship between job group and median nerve latency (Punnett testimony, Ex. 37–2; Gerr testimony, 27–2). Some who testified at OSHA's informal hearing have also stated that Dr. Nathan's articles use statistical presentation and analysis methods that obscure the evidence, and that not enough data are presented for the reader to independently evaluate whether the authors' conclusions are justified (Tr. 1521; Tr. 7850.). Low participation rates, unusual and inconsistent case definition, and inappropriate statistical analysis may also have limited the ability to detect increases in CTS prevalence over time in these studies with respect to work-related biomechanical factors. For example, the authors reported in the baseline study that they randomly selected the study participants (Ex. 26–990). However, they did not report the proportion of those who were selected and invited that actually participated. Since the 471 subjects represented only 26 percent of the total workforce of the participating companies, the representativeness of the sample is unknown, the ability to generalize from the data is highly limited, and the potential for selection bias is substantial. There is no comparative information on participants and non-participants with respect to demographics, occupational history or exposure, or medical history. The lack of clarifying information is particularly problematic because the direction of the selection bias could be either toward or away from the null value. This problem affects not only the 1988 baseline study but all future follow-up studies of the same cohort. Because of these criticisms, OSHA finds that the Nathan studies do not convincingly demonstrate a lack of association between workplace exposure to biomechanical risk factors and CTS.

In his written testimony, Dr. Peter Nathan calls into question the case definition for CTS relied upon by OSHA in their evaluation of the epidemiological studies (Ex. 32–241–3–13). He testifies that ‘‘there is general agreement among experts that classic symptoms associated with positive electrodiagnostic findings for the median nerve are necessary for a diagnosis of CTS'' but that ‘‘there is no general agreement that symptoms, in the presence of negative electrodiagnostic findings is equivalent to CTS.'' (Id., pg 4). Dr. Nathan then goes on to criticize OSHA and NIOSH, in their 1997 review, for accepting studies that use CTS case definitions without electrodiagnostic confirmation. He argues that longitudinal studies are the only study design of value for determining causation and concludes ‘‘if one required electrodiagnostic studies for a valid case definition of CTS, and a longitudinal design for establishing temporal relationships, then only one [his own] of the 31 studies analyzed by NIOSH would have met standard criteria for establishing causation.'' (Id., pg 11).

OSHA accepts that specific symptoms determined during clinical exam in combination with objective evidence of median nerve dysfunction through electrodiagnostic tests is the most definitive case definition for CTS at the present time. This has been supported by expert testimony not only from Dr. Nathan but Dr. Frederick Gerr (Ex. 37–2) and Dr. Gary Franklin (Tr. 13363). OSHA also does not dispute lack of agreement among experts on CTS diagnosis when symptoms exist in the presence of normal median nerve conduction. However, the relevant issue is whether clinical symptoms and signs in the absence of electrodiagnostic testing are an invalid CTS case ascertainment for the purposes of evaluating epidemiological evidence to determine if work-related physical factors are associated with the disorder. NIOSH addressed the issue in its 1997 review and cited studies that found satisfactory correlations between CTS diagnosed by nerve conduction and the disorder diagnosed by symptom questionnaire and physical examination (Ex. 26–1501; Ex. 26–439). It was also reported that clinical examination for CTS diagnosis without the benefit of nerve conduction studies has a sensitivity of 84 percent and a specificity of 76 percent (Ex. 26–1208). This indicates that without the aid of electrodiagnostics, one would make a CTS diagnosis when the disorder is not present (false positive) in about one in four subjects. On the other hand, clinical exam is expected to miss a diagnosis (false negative) when CTS is present about one in six subjects. While this degree of sensitivity and specificity may not be acceptable when making treatment decisions, such as surgery, OSHA does not believe it introduces substantial bias for purposes of evaluating epidemiological evidence.

OSHA does not agree with Dr. Nathan's assertion that only longitudinal studies are relevant in evaluating causation. Longitudinal prospective cohort studies are indeed the strongest epidemiological study design, especially for establishing temporal relationships. However, they often require extended periods of time, are more costly, and are not as numerous other study designs. Other types of epidemiology, such as cross-sectional and case-control studies, add evidence of causality in terms strength and consistency of association and exposure-response.

OSHA has examined the epidemiological data base and finds that even if one restricts the evidence to studies that used abnormal median nerve conduction to establish CTS case ascertainment, there is reasonable evidence of association between repeated, forceful exertions of the hand and CTS. There were eleven studies either reviewed by NIOSH in their 1997 review or submitted to the OSHA docket during the rulemaking process that found statistically significant associations between combinations of force, repetitive motion, awkward posture, and segmental vibration and CTS defined by electrodiagnostic criteria (Ex. 38–396; 26–942; 38–198; 26–1118; 26–1221; 23–1001; 26–1027; 500–41–28; 500–41–85; 38–181; 26–973). The entire body of epidemiological studies described in the preceding paragraphs is also supported by impressive biomechanical and psychophysical data, discussed in the following subsection, that shows sustained force on the flexor tendons along with flexion/extension of the wrist increases carpal tunnel pressure and reduces exertion and perceptions of discomfort. In his written testimony (Ex. 37–2), Dr. Fredric Gerr discussed his evaluation of the epidemiological studies that used abnormal nerve conduction to diagnose CTS and made the following statement in his oral testimony at the hearing:

> However, when significant positive associations between work and carpal tunnel syndrome are observed repeatedly, in study after study, by investigator after investigator, in country after country and at many different times, we must ask ourselves why. In my opinion, after reading these studies and considering all the possible reasons why so many studies show this relationship, the most reasonable, plausible, and likely explanation is that work really did cause the carpal tunnel syndrome observed in these studies. (Tr. 1525)

Biomechanical and Psychophysical Evidence

Several clinical and cadaver studies confirm that fingertip force, wrist flexion/extension, repetitive tasks and combinations of the above are able to raise carpal tunnel pressure (CTP) in a dose-dependant manner. Mean CTP was raised from 5 mm Hg in a neutral wrist position to approximately 100 mm Hg at 60 degree wrist extension and 80 mm Hg at 60 degree flexion in a population of CTS patients and controls (Weiss et. al. 1995, Ex. 26–236). CTP has been shown to significantly increase with increasing finger tip force (Rempel et. al. 1997, Ex. 26–889) and with clenching a fist or holding an object in a power grip (Seradge et. al. 1995, Ex. 26–325). There was a two- to three-fold increase in CTP when performing a repetitive task involving change in wrist posture 20 times per minute for 5 minutes (Rempel et. al. 1994, Ex. 26–1151). The elevated CTPs found in these human biomechanical studies are within the range of neuronal pressures shown to impair blood flow, axonal transport, and nerve conduction in experimental animals.

Psychophysical data support the biomechanical findings. They show that maximum acceptable weight (MAW) and torque (MAT) decrease and perceived exertion and discomfort increase with the frequency and duration of repetitive wrist motions. The psychophysical method was used to determine the preferred weights for one-handed horizontal transfer tasks (*e.g.* hand/wrist motion used to move an object across a supermarket scanner). Frequency and duration of the transfer movement significantly decreased MAW in an exposure-dependent manner and increased perceived exertion over an eight-hour session (Krawczyk et. al. 1992, Ex. 26–974). In another study, MAT was reduced over the course of a seven-hour trial of repeated flexion and extension of the wrist (Snook et. al. 1995, Ex. 26–212). The magnitude of MAT reduction correlated with the frequency of the task and perceived discomfort increased with increasing repetition.

Conclusion

The 1997 NIOSH report concluded the following with regard to the relationship between work-related physical risk factors and CTS:

> Based on the epidemiologic studies reviewed, especially those with a quantitative evaluation of the risk factors, the evidence is clear that exposure to a combination of the job factors studied (repetition, force, posture, etc.) increases the risk of CTS. This is consistent with the evidence in the biomedical, physiological, and psychosocial literature (Ex. 26–1).

OSHA also finds convincing evidence that jobs involving repetitive and forceful movements of the hand and wrist are linked to CTS. The epidemiological findings are supported by clinical, biomechanical, and psychophysical studies showing that repetitive tasks involving flexion/extension of the wrist and force to the flexor tendons result in substantial increases in CTP, reductions in measured exertion, and perceptions of discomfort. This evidence is clearly consistent with the pathophysiology of CTS in which elevated CTP can lead to compression of the median nerve resulting in the clinical signs and symptoms characteristic of this MSD. OSHA finds that the epidemiological and biomechanical literature convincingly demonstrates a causal relationship between forceful and repetitive exertions to the hand, especially in combination with a flexed wrist, and an increased risk of carpal tunnel syndrome. Forceful and repetitive exertion includes vibration from the use of hand-held power tools.

Hand-Arm Vibration Syndrome

Hand-arm vibration syndrome (HAVS) refers to a collection of signs and symptoms that occurs when vibration from a tool is transferred to a worker's hand or arm. The symptoms include numbness, blanching of the fingers, pain in response to cold exposure, and reduction in grip strength. These manifestations are similar to Raynaud's phenomenon triggered by cold temperatures. HAVS symptoms are believed to be the result of both neurological and circulatory disturbances, probably occurring independently and by unrelated mechanisms. Vibration may directly injure (as opposed to indirect damage from compression as in CTS) peripheral nerve endings and neuroreceptors causing numbness, tingling and pain in the fingers. Histopathology of persons suffering from HAVS indicate that vibration may also directly damage endothelial cells of the digital arteries resulting in a lack of response to certain vasodilators and thickening of the vessel walls. These physiological changes can cause vascular constriction and ischemia of the surrounding musculoskeletal and neural tissue. The clinical outcome is blanching of the fingers (''white finger''), loss of feeling, muscle weakness, and weakened grip strength.

Epidemiological Evidence

NIOSH reviewed 20 post-1988 epidemiological studies that addressed workplace risk factors and HAVS. Table V–6 summarizes some key aspects of these investigations, such as the occupations examined, the biomechanical risk factors they were exposed to, whether exposures were directly observed or measured during the study, and whether the health outcomes were verified by trained medical personnel during physical examination. Previous investigations were reviewed as part of the 1989 NIOSH criteria document on exposure to HAV (Ex. 26–392). In its 1997 evaluation, NIOSH featured four cross-sectional studies (Bovenzi *et al.*1988, Ex. 26–1500; 1994, Ex. 26–1239; 1995, Ex. 26–354; Nilsson *et al.*1989, Ex. 26–1148) and one prospective study (Koskimies *et al.*1992, Ex. 26–1490), which met most of NIOSH's criteria for high quality. These investigations determined HAVS based on medical exam and did not strictly rely on self-reported questionnaires. Standard and relatively uniform diagnostic criteria were used in defining HAVS cases. This generally included episodes of cold-provoked, well-demarcated blanching of the fingers, occurrence of vibration white finger attacks after employment and following use of power tools, and abnormal digital artery response to cold provocation. All studies used the Stockholm Taylor-Palmear scale to grade and stage symptoms. The five investigations included vibration measurements of exposure on tools used by the study subjects combined with information on exposure time obtained by direct interview.

The four cross-sectional studies found statistically significant positive relationship between exposure to vibration and prevalence of HAVS. The strength of this association was high with reported ORs ranging from 6 to 85. The one prospective study showed significant decreases in HAVS prevalence with decreasing exposure to vibration over time. All five investigations contributed evidence of exposure-response relationships between HAVS and vibration acceleration or duration of exposure. One study also documented a relationship between exposure and symptom severity.

TABLE V–6.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING HAND-ARM VIBRATION

Study	Job type studied	Physical Factors	Exposure basis	Diagnosis	Risk measure (95% CI)[1]
Nilsson (1989) Ex. 26–1148	Pulp mill machining.	V	Tool acceleration	Physical exam	OR=14–85 * (15–486)
Bovenzi (1995) Ex. 26–354	Forestry	V	Chain saw acceleration.	Cold provocation	OR=6.2–32 * (11–93)
Bovenzi (1994) Ex. 26–1239	Stone drilling	V	Tool acceleration	Physical exam	OR=9.3 * (4.9–17.8)
Bovenzi (1988) Ex. 26–1500	Stone cutting	V	Tool acceleration	Physical exam	OR=6.1 * (2.0–19.6)
Brubaker (1987) Ex. 26–762	Forestry	V	Chain saw acceleration.	Symptoms ischemia.	NR
Koskimies (1992) Ex. 26–1490	Forestry	V	Chain saw acceleration.	Physical exam	NR
Brubaker (1983) Ex. 26–763	Forestry	V	Questionnaire	Symptoms ischemia.	NR
Dimberg (1991) Ex. 26–1395	Aircraft machining.	V	Questionnaire	Questionnaire	NR
Krivekas (1994) Cited in Ex. 26–1	Forestry	V	Questionnaire	Pyhsical exam	OR=3.4–6.5 * (2.4–17.5)
Letz (1992) Ex. 26–384	Ship-yard	V	Tool acceleration	Questionnaire	OR=5.0–40.6 * (11–176)
McKenna (1993) Ex. 26–745	Machine riveting	V	Questionnaire	Cold provocation	OR=24 * (3.1–510)
Mirbod (1992) Ex. 26–1492	Forestry	V	Chain saw acceleration.	Physical exam	NR
Mirbod (1997) Ex. 500–121–49	Motorcyclists	V	Handlebar acceleration.	Questionnarie	NR *
Mirbod (1999) Ex. 500–121–48	Metal grinding	V	Job title	Physical tests	NR *
Mirbod (1994) Ex. 26–1491	Multiple industries.	V	Tool acceleration	Questionnarie	OR=3.8 * (2.1–6.8)
Musson (1989) Ex. 26–743	Power tool use	V	Tool acceleration	Questionnaire	NR
Nagata (1993) Ex. 26–1494	Chain saw operation.	V	Job title	Physical exam	OR=7.1 * (2.5–19.9)
Saito (1987) Ex. 26–1440	Chain saw operation.	V	job title	Cold provocation	NR
Palmer (1998) Ex. 500–121–56	Pavement breaking.	V	estimated tool acceleration.	Physical exam cold test.	OR=2.2–2.6* (1.4–4.8)
Palmer (2000) Ex. 500–121–57	Multiple industries.	V	Questionnaire	Questionnaire	PRR=1.5–2.2* (1.9–2.4)
Lindsell (1999) Ex. 500–205–13	Dockyard work	V	Job title	Cold provocations.	NR *
McGeoh (2000) Ex. 500–41–96	Welding	V	Questionnaire	Questionnaire	NR *
Shinev (1992) Ex. 26–836	Polishing	V	Tool acceleration	Physical exam	NR

TABLE V–6.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING HAND-ARM VIBRATION—Continued

Study	Job type studied	Physical Factors	Exposure basis	Diagnosis	Risk measure (95% CI)[1]
Starck (1990) Ex. 26–1510	Machining	V	Tool acceleration	Questionnaire	NR
Virokannas (1995) Ex. 26–891	Railway	V	Questionnaire	Questionnaire	NR
Miyashita (1992) Ex. 26–1223	Construction	V	Questionnaire	Questionnaire	OR=0.5 (0.1–11.8)

V=vibration; OR=odds ratio; NR=not reported.
* =p<0.05.
[1] 95% confidence interval expressed for the upper end of the risk measure range.

Bovenzi *et al.*found a significantly greater prevalence of HAVS in a group of 222 active forestry workers engaged in chain saw work as compared to randomly chosen shipyard workers unexposed to hand vibration (Bovenzi *et al.*1995, Ex. 26–354). The reported OR was 11.8 (95% CI 4.5–31.1) for all forestry workers and 6.3 (95% CI 2.3–17.1) for workers only using ''anti-vibration'' saws. The study found a nearly linear dose-response between HAVS prevalence and both vibration acceleration and years of exposure. Vibration exposure was determined from questionnaire reports on frequency of chain saw work and direct measurement of vibration produced by 30 different saws.

In two earlier studies, Bovenzi *et al.*examined HAVS in stone quarry drillers and carvers exposed to vibration from hand-held power tools along with an unexposed referent group. The first investigation found a statistically significant HAVS prevalence (OR=6.1; 95% CI 2.0–19.6) in 75 drillers/cutters compared to unexposed mill workers (Bovenzi *et al.*1988, Ex. 26–1500). There was a significant association between the level of vibration acceleration and severity of symptoms. In a much larger study of 570 quarry drillers/carvers and 258 polishers/machine operators not using power tools, an OR of 9.3 (95% CI 4.9–17.8) was reported (Bovenzi *et al.*1994, Ex. 26–1239). HAVS prevalence showed a significant increasing trend with estimates of lifetime vibration exposure.

In the Nilsson study, HAVS was examined in 89 platers and 61 office workers from a pulp mill machine manufacturing plant (Nilsson *et al.*1989, Ex. 26–1148). Prevalence of HAVS (OR=85; 95% CI 15–486) was much greater for platers with current exposure to vibration than unexposed office workers. There was a clear dose-response between HAVS and years of exposure.

Koskimies *et al.*investigated HAVS in a group of 124 forestry workers from 1972 to 1990 using a series of ten cross-sectional studies over time (Koskimies *et al.*1992, Ex. 26–1490). Their analysis showed a monotonic decrease in prevalence from 40 percent in 1972 to 6 percent in 1990. In a subcohort of 57 workers followed prospectively, HAVS cases decreased from 35 percent in 1975 to 6 percent in 1986. Over the same time period, modifications in chain saws used by the workers resulted in a reduction vibration acceleration from 14 m/s^2 to 2 m/s^2. While it is likely that the decline in HAVS is due to changes in the vibration acceleration, exposures and outcomes were never linked for individual workers.

The 1989 NIOSH criteria document (Ex. 26–392) provides some epidemiological evidence for an exposure-response relationship and temporal association between HAVS and vibration exposure. NIOSH analyzed HAV acceleration levels and prevalence of HAV-related vascular symptoms from 23 cross-sectional studies and found the two variables linearly correlated (R=0.67; p<0.01). Many of these earlier studies determined latency between vibration exposure and onset of HAVS symptoms providing some evidence of a temporal relationship. Unfortunately these data may be subject to recall bias since the mean latency was about six years and onset of symptomatology was often self-reported.

Most studies accounted for potential age-related effects by stratification of the analysis or through the use of multiple logistic regression. These studies also controlled for non-occupational disorders that involve symptoms similar to HAVS, such as idiopathic Raynaud's phenomena, peripheral neuropathy, alcohol-related illness, etc. According to NIOSH (1997, Ex. 26–1), it does not appear that these potential confounders account for the fairly strong and consistent association between HAVS and vibration.

Four studies that address vibration and HAVS were submitted into the OSHA docket following publication of the proposal (Mirbod *et al.*1999, Ex 500–121–48; Mirbod *et al.*1997; Ex 500–121–49; Ex 500–205–21; Palmer *et al.*1998, Ex 500–121–56; McGeoch and Gilmour 2000, Ex. 500–42–96; These are summarized in Table V–6. Studies that either measured tool acceleration or based HAVS on a combination of symptoms and medical tests found a significant association between segmental vibration exposure and this MSD (Ex. 500–121–49; Ex. 500–121–56 Ex. 500–121–48).

Conclusion

The 1997 NIOSH report concluded the following with regard to the relationship between work-related physical risk factors and HAVS:

> The 20 epidemiological studies show *strong evidence* of a positive association between high level exposure to hand-arm vibration and vascular symptoms of hand-arm vibration syndrome (HAVS). These studies are of workers with high levels of exposures such as forestry workers, stone cutters or carvers, shipyard workers, or platers. These workers were typically exposed to HAV acceleration levels of 5 to 36 m/s^2 * * * There is substantial evidence that as intensity and duration of exposure to vibrating tools increase, the risk of developing HAVS increases. [Ex. 27–1, Emphasis in original]

OSHA agrees with the NIOSH statements that intensity and duration of exposure to vibrating tools is linked to the risk of developing HAVS. Most of the epidemiological studies show a strong and consistent association between high-level exposure to HAV and HAVS symptomatology. The data indicate there are strong exposure-response relationships between the magnitude and duration of exposure and HAVS prevalence and severity. Some studies indicate temporal correlation between the chronic use of vibrating power tools and the onset of the disorder. A causal association between vibration and HAVS is consistent with clinical evidence showing that vibration damages nerve tissue and blood vessels in the fingers leading to symptoms characteristic of this MSD. Therefore, OSHA concludes that workers exposed to segmental vibration exposure, such as from long-term use of hand held power tools, are at increased risk of developing hand-arm vibration syndrome.

Hypothenar Hammer Syndrome

Hypothenar hammer syndrome (HHS) is a collection of vascular and neurological signs and symptoms that have been related to repeated trauma to the hand. HHS is associated with striking or pushing hard objects with the hypothenar region of the hand using the hook of the hamate bone as an anvil. At this location, the palmar blood vessels of the ulnar artery and the sensory branch of the ulnar nerve lie virtually unprotected near the surface of the skin and become trapped between ''the hammer'' (i.e. the hard object) and ''the anvil'' (i.e. the hamate bone). As a result, the blood vessels and nerves are especially vulnerable to injury by external mechanical stress. The repeated blunt trauma can lead to ulnar artery spasm, aneurysm formation, and/or thrombosis. These lesions cause arterial occlusion, vascular insufficiency, and post-traumatic ischemia of the surrounding tissue. The damage to neural tissue and reduced blood flow to the fingers are responsible for the most frequently reported symptoms of pain, numbness, cold feeling, discoloration and stiffness of the affected digits. A diagnosis can be made based on symptoms and a physical examination test of the radial and ulnar arterial blood supply to the hand, termed the Allen test. This test measures reflow time through the arteries following compression. Reflow time is substantially delayed in patients that suffer ulnar artery occlusion. More recently, arteriography has been used to confirm diagnosis of HHS. If elimination of the contact stress fails to resolve symptoms, vascular reconstructive surgery is often performed (Ex. 500–41–29).

There are four case studies of hospital or surgery clinic patients with HHS in the OSHA docket that have consistently implicated occupational exposure to repeated palmar trauma as a critical risk factor (Conn *et al.*1970 Ex. 26–821; Vayssairet *et al.*1987 Ex. 500–41–47; DeMonoco *et al.*1999 Ex 500–41–39; Ferris *et al.*2000 Ex. 500–41–33). These studies report on 58 patients altogether. In almost every case, the individuals suffering from the disorder reported a history of repetitive blunt trauma to the hand related to their jobs. Occupations such as carpenter, metal worker, machinist, and mechanic were most often cited. More infrequently, the HHS patients were engaged in hobbies in which the hand was exposed to frequent impact, such as karate and wood working. It should be noted that use of the hand as a hammer or to repeatedly apply direct impact to a hard object is a specialized combination of repetitive motion and mechanical force applied directly to a specific anatomical region. Other studies have reported HHS in workers repeatedly exposed to high-frequency mechanical stress to the palm from occupational use of hand-held vibrating tools (Nilsson *et al.*1989 Ex. 26–1148; Kaji *et al.*1993 Ex. 500–41–70). Thus, HHS is clearly another example of a work-related injury that occurs as a result of combined exposure to biomechanical risk factors (*e.g.* repetition, force, vibration) associated with other MSDs of the upper extremities.

Epidemiological Evidence

Besides the case studies mentioned above, there were two cross-sectional studies in the rulemaking docket that investigated HHS among workers (Little and Ferguson 1972 Ex. 500–41–89; Kaji *et al.*1993 (Ex. 500–41–70). Little and Ferguson examined 79 male vehicle maintenance workers from Australia for HHS who self-reported daily use of the hand as a hammer and 48 employees in the same shops who did not report habitual hand hammering. HHS was identified by both a positive Allen and Doppler test. The Doppler test charted blood flow from the radial artery and had shown good correlation with ulnar artery occlusion as measured by arteriography. The prevalence of HHS was 14 percent (11 out of 79) in the exposed workers and 0 percent in the referent population. The mean duration of employment (29.9 years) was significantly greater ($p<0.02$) in subjects with HHS than in men exposed to repeated trauma without the disorder (mean duration of 18.7 years).

Kaji *et al.*used arteriography to examine the hands of 330 Japanese workers that used vibrating tools in mining, forestry, and several other industries. They found a 7.3 percent (24 cases) prevalence of HHS among the workers. The injured subjects were predominantly coal miners, rock drillers and forestry workers that reportedly used air and jack hammers or chain saws. All suffered from HAVS as well as HHS. The mean duration of vibration exposure was 19.4 years (range 5 to 30 years). There was no unexposed referent group and no direct observation or measurements of vibration exposure in the study.

Conclusion

There is clear evidence that repeated and forceful impact between the hypothenar region of the hand and hard objects, such as hand hammering while on the job, or frequent exposure to mechanical stress from use of hand-held vibrating tools increase the risk of developing HHS. The occluded blood vessels that develop in the palmar region of the hand as a result of the blunt trauma created by these occupational risk factors have been cited in numerous case studies. The pathophysiology that links the initial damage with tissue ischemia and the characteristic symptoms that define HHS are also well established in the medical literature. Although limited in terms of numbers and design, the epidemiological findings are consistent with the clinical evidence and provide support for a causal association between repeated and forceful contact stress to the hand and this disorder. OSHA concludes that workers exposed to repeated and forceful impact between the hypothenar region of the hand and hard objects, such as hand hammering while on the job, or frequent exposure to mechanical stress from use of hand-held power tools, are at increased risk of developing hypothenar hammer syndrome.

E. Disorders of the Low Back

Low-back pain has long been associated with the performance of heavy physical work (Hales and Bernard 1996, Ex. 26–896; Klein, Jensen, and Sanderson 1984, Ex. 26–972; Rowe 1969, Ex. 26–318; 1971, Ex. 26–319). Studies have demonstrated that back disorder rates vary substantially by industry, occupation and by job within given industries or facilities (see Bigos *et al.*1986a, Ex. 26–871; Riihimaki *et al.*1989a, Ex. 26–58; Schibye et al 1995, Ex. 26–1463; Skovron *et al.*1994, Ex. 26–795). Recently, a NIOSH review (Bernard and Fine 1997, Ex. 26–1) concluded that several work-related factors are associated with low-back disorders. The National Academy of Sciences (NAS 1999, Ex. 26–37) also concluded that there is an association between certain work factors and low-back disorders. This section summarizes and discusses the evidence that physical work-related risk factors contribute to the pathogenesis of specific disorders of the back. The risk factors are (1) heavy physical work, (2) lifting and forceful movement, (3) bending, twisting and awkward posture, (4) static work postures, and (5) whole body vibration. Exposure to several factors often occurs concurrently in occupational settings and the evidence indicates that the risk of injury is greatest when more than one factor is present, reinforcing the concept that these MSDs are both multi factorial in etiology and that the joint effects of these risk factors can be synergistic. The terms ''back disorder'' or ''back MSDs'' are used to encompass all adverse health outcomes related to the back.

There are several types of evidence that interrelate to support the five risk factors stated above as causative factors for MSDs of the back. Information on pathophysiology provides evidence that links risk factors to the physiological, anatomical, and pathological alterations in soft tissues of the back. This speaks to the biologic plausibility that work-related risk factors contribute to these injuries. There is also a large volume of epidemiological data that provides evidence of an association between worker exposure to the identified risk factors and the occurrence of MSDs of the back. Finally, there is biomechanical and psychophysical laboratory research that provides much corroboration and adds to the plausibility and coherence arguments for a causal association determination.

Epidemiologic and laboratory-based research methods have both been used to evaluate the significance of various risk factors associated with work-related musculoskeletal disorders (MSDs). Epidemiologic studies are designed to look for significant associations between exposure to ergonomic risk factors and selected health outcomes (ranging from medically diagnosed disease entities to subjective reports of pain or discomfort) in selected populations of workers. NIOSH (Bernard and Fine, 1997, Ex. 26–1) performed a comprehensive review of the occupational epidemiology back MSD literature and after carefully selecting those highest quality studies, performed an assessment of the 42 studies by type of work-related risk factor. This evaluation draws from the NIOSH assessment and appends it with additional and more recent studies added to the record.

Although epidemiologic studies provide important insights into understanding the causes of MSDs, these studies are sometimes criticized due to their inability to precisely measure exposures to risk factors and the associated biomechanical and/or physiological responses to these exposures. Biomechanical models and laboratory studies do not replace epidemiological studies. However, these approaches provide important complementary information toward understanding the complex process of how exposures to ergonomic risk factors result in physiological responses that may ultimately lead to work-related injuries and illnesses. Presented here is a summary of laboratory studies and biomechanical models of work factors associated with increased risk of low-back injuries and disorders.

Laboratory studies are controlled scientific investigations of how humans respond when exposed to specific ergonomic risk factors (*e.g.,* forceful exertions, awkward work postures, high repetition, etc.) during simulated work activities. Responses include both objective biomechanical/physiological measurements, such as the electromyographic (EMG) activity of a working muscle, and subjective psychophysical measurements, such as ratings of perceived exertion. Most of the studies cited were performed in true laboratory settings. A few studies were performed in operational workplaces modified as necessary to collect data under carefully controlled conditions. Because of ethical issues related to the protection and safety of human subjects, laboratory studies are designed to keep exposures to risk factors at levels below the threshold of injury. As a result, these studies are generally incapable of ''proving'' a relationship between exposure and injury. Despite this limitation, laboratory studies provide important scientific insights as to how the body responds to ergonomic stresses. Combined with pathophysiological models of musculoskeletal injury mechanisms and epidemiological findings of positive relationships between exposure to ergonomic risk factors and musculoskeletal injury, laboratory studies are an essential element in understanding the causes and prevention of work-related overexertion injuries.

Biomechanical models simulate and/or predict how the musculoskeletal system responds to work factors such as external loads placed on the hands, work posture, and movement dynamics. These models can be used to estimate musculoskeletal stresses in the absence of a human experiment.

To understand the mechanisms by which work causes or contributes to the genesis or expression of low-back pain, it is first necessary to comprehend basic low-back anatomy and potential sources of pain. The majority of low-back disorders involve soft tissues (muscle and ligament) or the three-disc complex (the intervertebral disc and two facets). The latter may involve degenerative disc disease, disc herniation or osteoarthritic conditions. To understand how the performance of work causes lumbar disc disease, a review of lumbar anatomy, disc biochemistry, and disc biomechanics is presented here. With this foundation, pathogenic models are better appreciated. Several references are available for additional information (Bogduk and Twomey 1991, Ex. 26–720; Chaffin and Andersson 1991, Ex. 26–420; Williams, McCulloch, and Young 1990, Ex. 26–1563; Wiesel *et al.*1996, Ex. 26–1394). This discussion of the anatomy of the low back region is followed by a summary of the occupational epidemiology literature on the low back. This section is followed by a discussion of the biomechanical and laboratory research literature on stressors on the back.

The epidemiology literature is examined, to the extent possible, by grouping by specific work-related stress factor. The biomechanical and laboratory section discusses specific stressors separately for soft tissue disorders, disc disorders, and arthritis/spondylosis. In the conclusion section OSHA makes a determination of causality based on the consistency and strength of the epidemiology evidence and the coherence with the biomechanical and laboratory evidence. OSHA makes a determination of causality on each occupational risk factor examined, where possible; however, the final determination of work-related back MSDs is based on the totality of the evidence, not on each factor separately. OSHA believes that determining causal associations between individual work-related risk factors and MSDs is helpful, both in making a final determination of causality and in determining ways to abate risk. However, in discussing the epidemiology evidence it becomes clear that work often involves simultaneous exposure to multiple risk factors, even though in any particular situation exposure to one risk factor may predominate.

Anatomy of the Low Back

The lumbar spine is required to redistribute forces related to both intrinsic weight bearing and extrinsic load carrying. It is composed of five vertebral bodies separated by intervertebral discs acting as shock absorbers and stabilizers, as well as the posterior vertebral ring composed of pedicles, laminae, spinous and transverse processes, and facet joints that enclose and protect the spinal cord and spinal nerve roots. The lumbar vertebrae are numbered from the upper (cephalad) or first lumbar vertebra (L1) to the lower (caudad) or fifth lumbar vertebra (L5). Lumbar vertebrae are larger and wider than those in the dorsal and cervical spine, with the fifth vertebra generally the largest. This affords a larger surface area for the intervertebral disc and for load distribution. Disc anatomy and function will be discussed further in this section. At the lower end of the lumbar spine is the sacrum, a large, triangular bone representing the fusion of five sacral vertebrae, and the small coccyx.

Consistent with the greater vertebral size, the lumbar pedicles are shorter and wider than in the dorsal spine. Lumbar facets are posterior articular processes where the adjacent vertebrae interface. These joints help permit motion and bear some of the compressive load in addition to helping maintain stability of the spine against torsion and shear. Facet joints are synovial, and they contain nerve innervations in the synovial lining.

Anterior and posterior longitudinal ligaments attach to the superior and inferior margins of the lumbar vertebrae, and are innervated by pain fibers. The ligamentum flavum is a non-innervated structure that runs down the vertebral ring, and may hypertrophy after injury. This may become significant when a hypertrophied ligament infolds during spinal extension in an individual with disc bulging and facet arthropathy, thereby creating relative spinal stenosis. The interspinous ligament, also non-innervated, runs down the posterior margins of the spinous processes, posterior projections from the vertebral ring.

In adults, the spinal cord terminates as the conus medullaris at about the level of the first lumbar vertebra in the upper lumbar spine. Branching off from the conus is a bundle of lumbosacral nerve roots that resemble a horse's tail, called the cauda equina. These nerve roots pass through the lumbar and sacral portions of the spinal canal surrounded by the vertebrae, intervertebral discs, pedicles, laminae, facet joints, and spinal ligaments and eventually emerge as individual nerve roots through the intervertebral foramina. The neural foramen is bordered by the transverse processes of adjacent vertebrae, and the spinal nerve root takes its name from the adjacent (cephalad) vertebrae. The spinal cord is covered by the thecal sac, composed of meningeal tissue and cerebrospinal fluid.

Nerve roots in the lumbosacral spine include ventral (motor) and dorsal (sensory) components. Ventral roots contain motor axons sending signals to distal areas and control various skeletal muscle motor functions. Dorsal roots comprise primarily sensory axons receiving signals from distal areas or dermatomes. Thus, symptoms and signs of nerve root compression will vary with the location of the compressive lesion. As the intrathecal nerve roots reach the intervertebral foramen, the root sleeve gradually encloses the nerve more tightly, and eventually become extrathecal. Cell bodies for sensory axons are located in an extrathecal area of swelling called the dorsal root ganglion. These ganglia are encountered in or close to the intervertebral foramina. Axons of the nerve roots consist of collagen tissue called the endoneurium. This is covered by a thin root sheath that separates the endoneurium from a small amount of cerebrospinal fluid, and the epineurium and perineurium covering. Blood flow derives from segmental arteries that divide into three branches when approaching the intervertebral foramen. Nociceptors are present in facet synovium and outer layers of annulus (or extension of the posterior longitudinal ligament).

There are several important muscles of the low back. The psoas muscles are major spinal flexors that originate at the anterior vertebral borders and combine with the iliacus from the crest of the pelvic ilium and insert on the pelvis and lesser trochanter of the hip. Posteriorly, the erector spinae muscles attach to the spinous processes and laminae down to the sacrum to act as major spinal extensors. The interspinales muscles run between the five spinous processes of the lumbar spine and contribute to extension. Several other coactivating muscles assist in spinal stabilization and rotation. The rectus abdominis extends from the lower border of the rib cage to the pelvis and assist in flexion and maintenance of lordosis. The obliques and transversus are coactivators, and contribute to the generation of increased intraabdominal pressure, which some feel helps decrease compressive loading on the spine. External moments imposed on the lumbar spine during lifting are proportional to the weight and distance of the load from the spine and the weight and location of the individual's body segments. This results in a state of equilibrium where the external moments are counteracted by internal moments, primarily created by muscle contractions of flexors balancing extensors with additional stabilization from co-activators. Ligaments provide passive resistance or restorative moment to muscles. It is not clear, however, under what lifting conditions the ligaments play a significant biomechanical role.

Epidemiology of Work-Related Low Back Disorders

When discussing causal factors for low-back disorders, outcome measures vary and include low-back pain, impairment, and disability. Outcome measures may be defined in terms of severity and also whether the information was based on self-reports (interview or questionnaire) or objective criteria, *e.g.,* lumbar disc pathology.

Because there are numerous conditions in the low back which may cause low back pain, regardless of their relationship to work factors, and, in most cases the cause(s) cannot be determined with any degree of clinical certainty, the most common form of back disorder is ''non-specific symptoms,'' which often cannot be diagnosed. Therefore, in its review of the epidemiologic evidence for work-relatedness of low-back musculoskeletal disorders NIOSH (Bernard 1997; Ex. 26–1) included subjectively-defined health outcomes (*e.g.,* ''back pain'') because they comprise such a large subset of the total. From a total of 42 studies, 24 investigations defined the health outcome only by report of symptoms on questionnaire or interview, 2 used sick leaves and medical disability retirements and 6 used injury/illness reports. The NIOSH review of epidemiologic studies of low-back disorders examined the following potential risk factors related to physical aspects of the workplace: (1) Heavy physical work (HPW, work that has high energy demands or requires some measure of physical strength, jobs that impose large compressive forces on the spine), (2) lifting and forceful movements (LFM), (3) bending and twisting (BT, awkward postures), (4) static work postures (SWP), and (5) whole-body vibration (WBV). These physical risk factors almost always appear in workplaces in combinations with other work-related risk factors, as well as a myriad of personal, psychosocial and other factors. However, to the extent possible the review seeks to examine the physical factors separately. Furthermore, since this ergonomics rule does not contain provisions relating to WBV, this last portion of the NIOSH review will be substantively omitted from this analysis. Table V–7 contains a listing of both the higher quality back studies used in the NIOSH 1997 (Ex. 26–1) review and additional back studies in the record.

TABLE V–7.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING MUSCULOSKELETAL DISORDERS OF THE BACK

Study/exhibit number	Job type studied	Physical factors	Exposure basis	Physical exam.	Risk measure (95% CI)[1]
Punnett, 1991 Ex. 26–39	Auto assembly	HPW/BT LFM	Observation measurement.	Yes	OR=2.2–8.1* (1.4–4.4)
Astrand, 1987 Ex. 26–527	Pulp mill	HPW	Questionnaire job title.	Yes	OR=2.3*
Bigos, 1991 Ex. 26–1242	Aircraft assembly	HPW	Observation questionnaire.	No	NR*
Burdorf, 1991 Ex. 26–454	Concrete fabrication.	HPW/BT LFM	Observation measurement.	No	OR=2.8* (1.3–6.0)
Clemmer, 1991 Ex. 26–1345	Offshore drilling	HPW	Questionnaire job title.	No	OR=2.2–4.3*
Hildebrandt, 1995 Ex. 26–1516	Population based	HPW	Questionnaire job title.	No	OR=1.2* (1.33–1.55)
Heliovaara, 1991 Ex. 26–959	Population based	HPW/LFM	Questionnaire job title.	Yes	OR=1.9–2.5* (1.4–4.7)
Hildebrandt, 1996 Ex. 26–770	Steel maintenance	HPW	Questionnaire job title.	No	NR
Johansson, 1994 Ex. 26–1132	Metal workers	HPW/BT LFM	Questionnaire job title.	No	PRR=1.76 (1.25–2.47)
Leigh, 1989 Ex. 26–750	Population based	HPW	Questionnaire job title.	No	OR=1.5* (1.1–2.2)
Masset, 1994 Ex. 26–1470	Steel workers	HPW/BT	Questionnaire job title.	No	NR
Partridge, 1968 Ex. 26–1, pg. 6–81	Dock workers	HPW	Questionnaire job title.	Yes	OR=1.2
Riihimaki, 1989 Ex. 26–998	Concrete workers	HPW/BT	Questionnaire job title.	No	OR/1.0–1.5*
Riihimaki, 1994 Ex. 26–1188	Heavy equipment operators.	BT	Questionnaire job title.	No	NR
Ryden, 1989 Ex. 26–809	Hospital employees.	HPW/BT	Questionnaire job title.	No	OR=2.2* (1.25–4.15)
Svensson, 1989 Ex. 26–732	Population based	HPW/BT LFM	Questionnaire job title.	No	OR=1.2*
Videman, 1990 Ex. 26–1023	Hospital patients	HPW/SWP LFM	Questionnaire job title.	autopsy	OR=2.8–24.6* (1.5–409)
Bergenudd, 1988 Ex. 26–1342	Population based	HPW	Questionnaire job title.	No.	OR=1.8* (1.2–2.7)
Burdorf, 1990 Ex. 26–1518	Crane operators	HPW/SWP LFM	Questionnaire job title.	No	OR=0.5–4.0 (0.8–21.2)
Chaffin, 1973 Ex. 26–876	Electronics manufact..	LFM	Job title	No	OR=5.0*
Holmstrom, 1992 Ex. 26–36	Manual handling	LFM/BT SWP	Questionnaire job title.	Yes	OR=1.3* for BT (1.1–1.5)
Huang, 1988 Ex. 26–1204	School lunch workers.	LFM	Observation measurement.	No	NR
Kelsey, 1975 Ex. 26–1134	Case/control herniated lumbar disc.	LFM/SWP	Questionnaire job title.	No	NR
Kelsey, 1984 Ex. 26–752	Case/control prolapsed lumbar disc.	LFM/BT	Questionnaire job title.	Yes	OR=3.1* (1.3–7.5)
Knibbe, 1996 Ex. 26–766	Nurses	LFM	Questionnaire job title.	No	OR=1.3
Magora, 1972, 1973 Ex. 26–1513	8 occupations	LFM/BT	Observation measurement.	No	OR=1.0–1.7* (1.3–2.1)
Liles, 1984 Ex. 26–33	Manual handling	LFM	Measurement	No	OR=4.5* (1.02–19.9)
Marras, 1995 Ex. 26–14–12	Manufacturing workers.	LFM/BT/ HPW	Observation measurement.	No	OR=10.7* (4.9–23.6)
Toroptsova, 1995 Ex. 26–1, pg. 6–92	Machine builders	LFM/BT/ SWP	Questionnaire job title.	Yes	OR=1.4*–1.7*
Undeutsch, 1982 Ex. 26–731	Airport baggage handlers.	LFM	Questionnaire job title.	Yes	NR
Walsh, 1989 Ex. 26–1437	Population based	LFM/SWP	Questionnaire job title.	No	OR=1.5–2.0* (1.1–3.7)
Skov, 1996 Ex. 26–674	Saleworkers	SWP	Questionnaire job title.	No	OR=2.5* (1.2–4.9)
Mandel, 1987 Ex. 500–41–92	Hospital nurses	LFM	Questionnaire	No	OR=1.4*
Thorbjornsson, 1998 Ex. 500–119–7	Random selection from 2500 medical exams.	HPW	Questionnaire	Yes	OR=1.4* (1.0–2.0)

TABLE V–7.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING MUSCULOSKELETAL DISORDERS OF THE BACK—Continued

Study/exhibit number	Job type studied	Physical factors	Exposure basis	Physical exam.	Risk measure (95% CI)[1]
Kuh, 1993 Ex. 500–41–80	Population based	LFM	Job title	No	RR=1.3* (1.0–1.7)
Smedley, 1995 Ex. 500–41–40	Hospital nurses	LFM	Questionnaire	No	OR=1.3–1.8* (1.3–2.5)
Venning, 1987 Ex. 500–41–49	Nurses	LFM	Questionnaire job title.	No	OR=1.7–4.3*
Xu, 1997 Ex. 500–119–9	Population based	BT/HPW	Questionnaire	No	OR=1.3–1.7* (1.51–1.93)
Stobbe, 1988 Ex. 500–41–45	Hospital nurses, LPNs, attendants.	LFM	Questionnaire	No	OR=1.0–2.7*
Park, 1997 Ex. 500–41–104	Population based	HPW/LFM/BT	Questionnaire	No	OR=1.88* (1.64–2.15) for HPW
Latza, 2000 Ex. 500–41–83	Population based	HPW/BT/SWP/LFM	Questionnaire	No	OR=1.77–1.89*
Latza, 2000 Ex. 500–119–6	Laying sandstone	HPW/LFm	Questionnaire	Yes	PR=1.8–2.6* (1.1–6.5) for hours/shift
Kerr, in press Ex. 500–39	Automotive workers.	LFM/BT	Measurement	No	OR=1.7–2.0* (1.22–3.59) for biomechanical factors
Krause, 1998 Ex. 500–87–2	Transit vehicle workers.	HPW	Questionnaire records.	Yes	OR=3.04* (1.85–5.00)
MacFarlane, 1997 Ex. 500–41–91	Population based	LFM	Questionnaire	Yes	OR=1.1–2.5* (1.5–4.1)
Waters, 1999 Ex. 500–41–54	Lifting case/control.	LFM	Questionnaire measurement.	No	OR=2.45* (1.29–4.85)
Wang, 1998 Ex. 500–41–52	Manual handling	LFM	Measurement	No	Significant correlation p<0.01
Van Poppel, 1998 Ex. 500–121–71	Airline baggage handlers.	HPW	Questionnaire	No	NR
Vingard, 2000 Ex. 500–41–51	Population based	HPW/LFM/BT	Questionnaire	No	RR=1.4–2.9* (1.2–6.8)
Luoma, 1998, (2000) Exs. 500–71–39, (38)	Not by identifiable risk factor but by title—office carpenter machine driver		Job title	Yes	OR=2.0–8.1* (2.4–21.1)
SHARP, 1993 Ex. 30–7	Data entry	SWP	Questionnaire	No	NR* (p<0.05)
Larese, 1994 Ex. 38–130	Hospital nurses	LFM	Measurement	Yes	OR=1.9–2.4*
Myers, 1999 Ex. 500–119–10	Case/control municipal workers.	HPW/BT/LFM	Questionnaire measurement job title.	No	OR=1.6–2.0* (1.13–3.67) for BT

HPW=heavy physical work; LFM=lifting or forceful movements;
BT=bending and twisting or other awkward postures; SWP=static work postures
IR=incidence rate; OR=odds ratio; RR=relative risk; NR=not reported; *=p<0.05
[1] 95% confidence limits expressed for the upper end of the risk measure range.

Heavy Physical Work

The NIOSH summary reviewed the eighteen higher quality studies which address the association between HPW and LBP (Ex. 26–1, pgs. 6–4 to 6–13). Of these eighteen, 14 were cross-sectional, 3 were prospective) and one was a case-control (Ryden *et al.* 1989, Ex. 26–801). Study populations included individuals working in health care, office work, manufacturing and construction, and all with different physical work requirements. Despite the fact that the studies assessed different groups of workers, defined disorders and assessed exposures in many ways, nine of these eighteen found statistically significant positive associations. The relative risk estimates for these significant associations generally ranged from 1.1 to 4.3, although one study of cadavers found a significant OR=12.1 (95% C.I. 1.4—107) for the risk of osteophytosis among those in the HPW category. OSHA notes that if there were no true associations only one of these eighteen studies should have shown a statistically significant result.

With regard to temporality, this is usually most easily studied with a cohort study design. Of these three studies, one had no association (Bigos *et al.* 1991, Ex. 26–1241), while two showed statistically significant increases (Clemmer *et al.* 1991, Ex. 26–1345; Bergenudd *et al.* 1988 Ex. 26–1342). Two cross sectional studies also considered temporal relationships by including in the analysis only those MSD-free when starting their current jobs, and both showed positive associations (Burdorf *et al.* 1991, Ex. 26–454; Burdorf and Zondervan 1990, Ex. 26–1518). Thus, these results are consistent with a positive finding for temporality.

OSHA also notes that the Bureau of Labor Statistics Annual Survey of

Injuries and Illnesses as well as other health interview surveys have found elevated LBP rates and MSDs in typical HPW associated occupations, (female) nursing aides, orderlies and attendants; personal care; and air transportation workers (see the risk assessment in section VI of this preamble). While survey statistics may not be definitive in themselves, they show a pattern of consistency with the results from the epidemiology studies discussed above. OSHA notes that these types of population-based studies can be less reliable than other epidemiology designs due to generally less knowledge about individual exposures.

Since OSHA's Ergonomics proposal was published, several other studies on HPW and LBP have been put into the record. Several are discussed below:

The Vingard *et al.*, 2000 (Ex. 500–41–114) population-based case-referent study suggests that prolonged exposure to many years of heavy work and forward bending (cumulative exposure) increases the risk of LBP. The Latza *et al.,* 2000 (Ex. 38–424) prospective study, after adjusting for trade, found exposure-response relationships for hours per shift laying sandstone (PR=1.8, 95% C.I. 0.7—4.7, for 0 to <2 hours; PR=2.6, 95% C.I. 1.1—6.5, for ≥ 2 hours; trend test p=0.03), and stone load (PR=1.8, 95% C.I. 0.4—9.5, for intermediate level; PR=4.0, 95% C.I. 0.8—19.8 for high level; trend test p=0.03). The Krause *et al.* 1998 study (Ex. 38–272) found that cable car crews performing the heaviest physical labor had a three-fold increased risk of spinal injury compared with bus driver (OR=3.04, 95% C.I. 1.85—5.00). This five year prospective study of 1,871 transit vehicle operation also found both physical workload and psychosocial job factors independently predict spinal injury in transit vehicle operators.

OSHA has also considered three other studies available since the proposal on HPW. Two of these three studies found at least one statistically significant association between LBP and HPW while the third suffered from methodological problems. Myers *et al.* (1999, Ex. 500–119–10) carried out a case-control study of 274 workers with symptoms and signs of low back pain from four municipal departments (a 73% participation rate). The stated purpose was to identify factors, both physical work characteristics and psychosocial factors, associated with acute low back injury. Two randomly selected controls were chosen, one matched according to work tasks, which the authors stated ''could be used to examine importance of non-ergonomic factors'' and one matched by department. Cases were defined from reports from the city Occupational Medicine Clinic, and were those who had been assigned restricted work or had lost work time due to back injury. Further information was gathered from questionnaire about work history, work characteristics, work injuries, back pain, psychosocial behaviors, and demographics. Exposure was assessed by questionnaire and measurement; the strenuousness of each worker's job classified as light, medium, or heavy according to weight capacity, frequency and duration of sitting-standing-walking. Analyses screened for 2-way, 3-way and 4-way interactions. The variables examined included a work movement index, which combined twisting, extended reaching, and stooping. Factor analysis was used to determine the important psychosocial factors from the Job Content Questionnaire. There was no difference in the prevalence among the cases and controls regarding physical work demands (light, medium, and heavy), nor twisting or extended reach. However, because the cases and controls were matched on job department and/or job title, the design provided little ability to examine those job factors. This would also preclude any conclusions pertaining to the relative strength between psychosocial and physical factors. Although the authors noted that their ''findings underscore the importance of adopting a model that does not focus entirely on physical factors in relation to the multifactorial problem of back injury,'' their study design did not allow them to focus adequately on the physical factors. This study focused on the psychosocial aspects of the acute back pain but did not adequately address work factors.

Park *et al.* (1997, Ex. 500–41–104) carried out a cross-sectional study using data from the National Health Interview Survey Occupational Health Supplement, 1988. In this survey, 30,074 randomly selected employed persons were asked about back pain occurring every day for a week or more in the previous 12 months. The response rate was 87%. Causes of back pain were classified into 3 groups: (1) Injury and/or repeated activities that occurred at work; (2) injury and/or repeated activities that occurred outside work; and (3) other reasons (illness, diseases, unknown). Self-reported work activities included repeated activities with lifting, pushing, pulling, bending, twisting, or reaching. Occupation was coded according to the 1980 classified Index of Industries and Occupations of the U.S. Bureau of Census. Confounders were controlled for in the regression models. Results found that 17.6% of workers reported back pain every day for one or more weeks during a 12 month period; 26.9% of these reports were attributed to repeated activities (RA) at work; 17% to RA and injury, and 8.2% to injury at work. The majority of back pain found in blue collar workers (OR=1.38, 95% C.I. 1.22—1.54), was attributed to work; whereas the majority of BP in white-collar workers was not attributed to work conditions. A higher proportion of workers with work-related back pain caused by injury or RA had pain in the lower back extending to lower body parts, had missed work more than 5 days, and had changed jobs than had workers with non-work related back pain. Other significant variables were ''strenuous physical activities at work more than 4 hours per day [HPW]'' (OR=1.88, 95% C.I. 1.64—2.15), ''repetitive movements more than 4 hours per day'' (OR=2.4, 95% C.I. 2.1—2.77) and current smoking (OR=1.57, 95% C.I. 1.39—1.76), BMI greater than 28 kg/m^2 (OR=1.35, 95% C.I. 1.2—1.52) and age 35–59 (OR=1.31, 95% C.I. 1.2—1.46). The strength of this study is the rigorousness used by the National Center for Health Statistics in their study design and analysis. A weakness is that it is based on questionnaire data.

Thorbjornsson *et al*, (1998, Ex. 500–119–7) used data collected over 24 years for its cohort study. 252 women and 232 men were randomly selected from 2500 for medical examination (a 62% participation rate). In 1969 these subjects had a questionnaire-based interview and an examination. LBP was defined as pain, aching, or stiffness in the lower back in the past 12 months. There was a follow-up a re-examination in 1993. Exposure assessment was based on a questionnaire from 1969 using a dichotomous scale for 11 work factors (*e.g.*, high mental load (hectic work, exhaustion at end of day), poor supervisor social support, monotonous work, full time work; night or shift work, overtime work, high physical load (40 kg for women, 60 kg for men or physical exhaustion at end of day), severe vibrations, and non-working conditions, using a dichotomous scale. (Insufficient or unsatisfactory leisure time, few or unsatisfactory social contacts, additional domestic workload). Risk factors for back pain during 1972–1992 included: for women, unsatisfactory leisure time (OR=1.5, 95% C.I. 1.1—2.0); for men, 1972–1993: high physical load (OR=1.4, 95% C.I.1.0—2.0), vibrations (OR=1.4, 95% C.I. 1.0—2.2), and unsatisfactory leisure time (OR=1.5, 95% C.I. 1.1—2.0). Cumulative incidence ratios for 1972–1993, adjusted for age, and earlier back pain were 38% for women and 43% for men.

Lifting and Forceful Movements (LFM)

The NIOSH summary reviewed the 18 higher quality studies that address the association between LFM and LBP (Ex. 26–1, pgs. 6–13 to 6–21). Of the eighteen studies, 13 were cross-sectional, two were prospective, and three were case-control designs. Only the one case-control study of back pain in auto workers (Punnett *et al.* 1991, Ex. 26–39) fulfilled all four of their quality evaluation criteria. Besides auto workers, among the study groups which showed increased risks to workers with high lifting or manual materials handling (MMH) demands were nursing aides, baggage handlers, workers in manufacturing and electronics, crane operators, and concrete fabricators, although several studies focused more on the actual stresses within the job rather than job title. In all 10 of the eighteen studies showed at least some statistically significant associations between LFM and LBP, with the significant risk estimates generally ranging from 1.2 to 5.2 (Ex. 26–1, pg. 6–41). For the most part, higher ORs were observed in high-exposure populations. The highest risk estimate (OR=10.7) was from a group of workers in a cross-sectional study by Marras *et al.*, (1993, Ex. 26–170; 1995, Ex. 26–171). The MMH workers with this highest OR had the highest combination of exposure measures relating to five specific risk factors associated with lifting, twisting, frequency, angle, and force, again strongly suggesting synergism among the risk factors. The 5 studies reviewed for this chapter which showed no association between lifting and back disorder used subjective measurements of exposure, had poorly described exposure assessment methodology, or showed little differentiation within the study group.

With regard to temporality, both the prospective studies which assessed exposures prior to identification of MSDs, had positive association. Also, of the four (three cross-sectional and one case-control) studies which attempted to address temporality, three found positive relationships between lifting and LBP. OSHA also notes that of the eight studies which examined exposure-response relationships in some manner, six found positive associations, including Punnett *et al.*, 1991, (Ex. 26–39) while two others did not (Ex. 26–1, pg. 6–20).

Since OSHA's Ergonomics proposal was published, several other studies on LFM have been put into the record. Some are more recent, and these are discussed first, while several older studies, not part of the original review, are also discussed below.

With respect to the more recent studies, published since 1996, the studies of LFM and LBP in a wide variety of industries provide substantial additional evidence that repetitive lifting is associated with low back disorders.

There are a limited number of negative studies which provide little evidence to weaken the overall conclusion from the much large number of positive studies. Other reportedly negative studies of lifting and low back disorders have limitations. For example, Feyer, Herbison *et al.* (2000, Ex. 26–1499) conducted a prospective study of low back pain among nursing students, but there was no evaluation of the physical demands of jobs and there was a 1/3 dropout from the study.

In addition to the more recent studies, six older studies, not in the proposal, also discussed the relationship between LFM and LBP. Mandel and Lohman (1987, Ex. 500–41–92) showed an increased risk of back pain with lifting more than10 patients per week (OR=1.39, 95% C.I. 1.05—1.84) in a cross-sectional study in which 428 registered nurses in a Midwestern hospital participated (rate was 65%). Fifteen percent of the nurses had reported experiencing LBP for the first time during the study year, with most episodes occurring in younger workers. However, while intensive care unit nurses lifted significantly more patients, LBP was not associated with work area. The most significant associations were having LBP prior to the study year and having pain in another part of the spine. The limitations of this study are its participation rate and both its exposure assessment and health outcome definition. However, despite these limitations, it provides support for patient lifting as a risk factor for LBP in nurses.

Larese and Fiorto (1994, Ex. 38–130) in a cross-sectional study compared 425 general nursing staff from an urban hospital to 198 oncology nurses (participation rate: 91.4%). LBP cases were based on clinical examination or X-ray findings. Exposure measurements included the analysis of working conditions, which revealed both groups of nurses had to do frequent and heavy lifting, lowering, and pushing-pulling. Differences were found when analyzing the number of patients assisted by the different nursing groups: the staff nurses cared for double the number of patients compared to the oncology nurses. Calculating crude odds ratios showed that general nurses had an OR=1.9 (95% C.I. 1.32—2.76) for LBP and an OR=2.4 (95% C.I. 1.35—4.27) for back pain sick leave compared to the oncology nurses. The authors used the Mantel-Haenzel chi-square statistics to control for age and for occupation among the two groups, but multivariate analysis to control for both factors simultaneously was not done. The authors concluded that ''comparison between the two hospitals suggests factors associated with the disorders: work tasks and particularly nurses/patients ratio are more important than age and length of exposure.'' The authors did not present the data from which they drew these conclusions.

Stobbe *et al.* (1988, Ex. 500–41–45) carried out a retrospective study of three hospital groups at a major medical center including 143 licensed practical nurses, 252 nurses aides, and 20 attendants. Two groups were identified, one exposed to frequent patient lifting, one not. Health outcome was defined as back injuries, including both lost-time and non-lost-time injuries. Lifting frequency was determined through interviews with the nursing director, the head nurse, and nursing supervisors. High frequency lifting was defined as an average of more than 5 patient lifts per shift. Low frequency lifting (control group) was defined as average of less than two patient lifts per shift. Nursing personnel with estimated exposures of 3–5 patient lifts per shift were excluded. Lifting frequency (OR=2.7, p=0.009), and length of employment (p=0.0085) remained significant in the logistic regression model, while occupation did not. The authors used a survivor type conditional analysis which assumed that when a person with a back injury report resumed work, the future probability of injury was the same as if there had been no previous injury. This assumption has not been supported in other studies.

Kuh *et al.* (1993, Ex. 500–41–80) in their longitudinal study of 3262 same age Great Britain natives (born the first week, 1946), looked at risk factors for LBP, mainly the association with stature and height, but also lifting. The study population had been followed every 2 years in childhood, and every 5 years as adults. Participation rate for this study was only 60.8%. Exposure was assessed using job title and occupational histories. A matrix assigned jobs to three levels of lifting—low, intermediate and high. The interaction of height and occupational lifting as a risk factor for LBP was investigated for men. The onset of back pain symptoms was significantly more common in men whose jobs were likely to involve heavy lifting (RR=1.3, 95% C.I. 1.0—1.7). The main occupations of heavy lifting associated with LBP were farming and construction. There was discussion of reporting bias, recall bias, lack of direct information about lifting at work. The weakness of this study is using ''job title'' as surrogate for exposure, but a bias here is likely to mask true associations.

Smedley *et al.* (1995, Ex. 500–41–40) conducted a cross-sectional survey of 2,405 nurses using a self-administered questionnaire to investigate the risk factors associated with low back pain. The response rate was sixty-nine percent. Among those who responded to the survey, 1616 were women. Due to the low number of male respondents, this study focused on female workers. Low back pain was defined as pain lasting for longer than a day in an area between the twelfth rib and the gluteal folds (indicated on a chart). Questions about non-musculoskeletal symptoms, included in the questionnaire, were designed to investigate whether psychological factors that influence reporting of other symptoms also affect reporting of LBP. After adjustment for age, height and non-musculoskeletal symptoms, significant associations were found for: frequency of manually moving patients around on the bed; manually transferring patients between bed and chair; and manually lifting patients from the floor.

Frequency	OR	95% C.I.	Factors controlled
Manual Movement of Patients on Bed			
5–9 moves	1.5	1.1–2.2	Age/height.
5–9 moves	1.6	1.1–2.3	Age/height/non-musculoskeletal symptoms.
10+ moves	1.7	1.2–2.3	Age/height.
10+ moves	1.7	1.2–2.4	Age/height/non-musculoskeletal symptoms.
Manual transfer of patients between bed and chair			
5–9 moves	1.7	1.2–2.3	Age/height.
5–9 moves	1.8	1.3–2.5	Age/height/non-musculoskeletal symptoms.
10+ moves	1.5	1.1–2.1	Age/height.
10+ moves	1.5	1.1–2.1	Age/height/non-musculoskeletal symptoms.

Evaluation of the task of manually lifting patients from the floor resulted in similar significantly elevated risks regardless of whether age and height alone or all three factors, *i.e.*, age, height, non-musculoskeletal symptoms, were controlled for (OR=1.3, 95% C.I.1.0—1.6). In this study, nurses who often report non-musculoskeletal symptoms, such as low mood or stress, were significantly more likely to report low back pain. For example, frequent low mood was strongly associated with subsequent back pain (OR=3.2, 95% C.I.. 2.2—4.8). Specific manual handling tasks were associated with an increased risk of back pain while no such association was found in this study among nurses using mechanized patient transfer (with hoists).

A study of personal and job-related factors that may affect the incidence of back injuries among 5,649 nurses was conducted by Venning *et al.* (1987, Ex. 500–41–49). A ''back complaint'' was defined as any work-related injury or complaint of discomfort in the back and reported through an employee health office. Nurses were surveyed by questionnaire and then observed for a 12-month study period. As annual injury rate of 4.9% was observed. Four factors were found to be highly statistically significant ($p<0.01$) predictors of back injury. Risk estimates for all four factors (service area, lifting, job category, and previously reported back injury), remained significantly elevated when a forward stepping model of logistic regression was applied. The observed adjusted odds ratios were: 4.26 for service areas where lifting occurs most often as compared with areas where lifting occurs least; 2.19 for daily lifters as compared with light, occasional, and nonlifters; 1.77 for nursing aides as compared with registered nurses and supervisory personnel; and 1.73 for individuals who have previously reported back injury as compared with those who have not reported previous injury. No other factors, including age, physical activity, availability of lifting aids, height and weight, and instruction in back care and lifting procedures, were significantly associated with reporting of back injury. The influence of service area is not easily explained. The authors chose to define service area as a work activity. With an attitudinal measurement, job satisfaction may have also proven to be a significant factor. The question would then be one of temporality and association between those factors. It is clear, however, that service area assignment is a major risk factor. When two employees who are similar in job category and history of back injury are assigned to different service areas, the risk of back injury is dependent on that ward assignment.

In summary, seven of the eight new studies, and all six of the older studies (all of nurses and nursing assistants who did more frequent patient lifting), found at least one statistically significant association between LFM and LBP. When considered with the 10 studies originally reviewed by NIOSH which found statistically significant associations, this epidemiology data base provides strong evidence for a causal association between LFM and LBP.

Bending and Twisting/Awkward Postures (BT)

The NIOSH summary reviewed the 12 higher quality studies which addressed the association between BT and LBP (Ex. 26–1 pgs. 6–21 to 6–26). Of the twelve, nine also examined the effects of occupational lifting, although for all but the Marras *et al.*, (1993, Ex. 26–170; 1995, Ex. 26–171) analysis discussed above the presented comparisons for LFM and BT are different. As with the analysis for BT above, only the Punnett *et al.*, 1991 case-control study fulfilled all four of the quality evaluation criteria. Nine studies were cross-sectional, two were case-control and one was prospective. Of the twelve studies seven reported statistically significant associations, with the significant risk estimates generally ranging from 1.2 to 3.5. However, two of these ORs were higher; in addition to the previously mentioned OR of 10.7 in the Marras *et al.* (Exs. 26–170, 26–171) study, Punnett *et al.*, 1991, (Ex. 26–39) using a multivariate analysis that adjusted for covariates, found a statistically significant OR=8.09 (95% C.I. 1.4–44) for time in a non-neutral position for auto workers. Several studies suggested that both lifting and awkward postures were important co-contributors to risk of low back disorder.

With regard to temporality and exposure-response, three studies—one prospective, one case-control, and one cross-sectional—attempted designs and analysis to investigate temporality. Only the case-control study of Punnett *et al.*, 1991 (Ex. 26–39) found a strong association between exposure to awkward postures and back pain. The Riihimaki *et al.*, 1994 (Ex. 26–1188) prospective study comparing heavy equipment operators with office workers found a three year prevalence ratio for LBP of 1.4 (95% C.I. 1.0–1.9) (Ex. 26–1, 6–86). For exposure-response relationships between posture and low back disorder, five of the six studies which attempted such an analysis found significant relationships between some incremental index of LBP and exposures relating to awkward postures.

Since OSHA's Ergonomics proposal was published, three other recent studies on BT and LBP have been put into the record. These are discussed below:

With respect to the two most recent studies, both Latza *et al.*, 2000, (Ex. 38–424) and Vingard *et al.*, 2000 (Ex. 502–410) have been discussed above, in both the HPW and LFM sections. The Latza *et al.* study, in a logistic regression analysis controlling for several covariables, found that risk factors for LBP included working in a bent position, for men, with an OR =1.89 (95% C.I. 1.03–3.46). This OR was greater than those, computed in the same regression analysis, for carrying heavy loads, OR=1.47 (95% C.I. 0.97–2.24), and heavy physical work OR=1.77 (95% C.I.1.06–2.93). For the Vingard *et al.* study, there were statistically significant associations for both men and women when related to both heavy and cumulative exposures. When the combined physical exposures of ''heavily exposed to forward bending'' and ''manual handling over the last ten years'' were added to current exposures, the estimated RRs in men was 2.8 (95% C.I. 1.1–7.5) and in women 2.9 (95% C.I. 1.2–6.8). Multiple logistic analyses adjusting for a wide range of variables including age, social support at work and outside work, low back pain earlier, and negative life events, did not identify many physical or psychosocial factors as significant predictors. However, for ''forward bending greater than one hour'' the RR in men was 1.8 (95% C.I. 1.1–3.1), and in women 1.2 (95% CI 0.7–1.8).

The third recent study, Xu *et al.*, (1997, Ex. 500–119–9), examined bending and twisting, as well as physically hard work in the Danish population in a cross-sectional survey conducted in 1990. A random sample of 5,185 workers with similar sex, age, and occupational distributions as in the Danish population was selected, with a response rate of 89.3%. The health outcome was defined as symptoms of back pain in the past 12 months, assessed by structured interview, and included conditions of pain, ache, discomfort localized in the lower back, regardless of intensity and severity. Occupational exposure information included duration of daily exposure, vibrations affecting the whole body, physically hard work, frequently twisting or bending, sitting down, standing up, walking a lot, working with hands raised, concentration demands, repetition, and lifting heavy loads. The psychosocial factor ''concentration demands'' was also included in the model. Confounders controlled for included gender, age group, educational level, and duration of employment. There was a significant dose-response trend towards the greater prevalence of LBP with a greater proportion of the day exposed to the risk factors, for two physical factors—physically hard work (OR=1.28, 95% C.I. 1.08–1.52), and frequent twisting or bending (OR=1.71, 95% C.I. 1.51–1.93). Concentration demands and standing up were also significantly positively associated with the occurrence of low back pain. The results indicate that the associations of risk factors with LBP were stronger among those required to work for 37 or more hours/wk. The authors addressed issues of recall and participation bias.

In summary, the statistically significant associations of BT and LBP seen in seven of the 12 NIOSH reviewed studies and in all three of the more recent studies, provide by strong evidence that the associations observed are real.

Recent Epidemiology Reviews of Work-Related Low Back Disorders

Since the NIOSH 1997 review, there have been three published reviews which bear on the epidemiology of the work-related risk factors for back pain discussed above. The first is the NAS report, discussed elsewhere in this Health Effects section, which reviews and affirms the appropriateness of the methodology and the conclusions of the NIOSH 1997 review (Exs. 26–37). The other two are recently published reviews relating specifically to risk factors, especially physical stress factors, for back pain. One of these reviews also examines psychosocial factors (Ex. 500–71–24). These are discussed below.

The Burdorf and Sorock (1997, Ex. 500–71–24) review assessed the epidemiologic evidence of occupational risk factors for back disorders. They included only those published studies that clearly described exposure measures, had quantitative estimates of risk for work-related factors, and did not have evidence of a serious methodological problem. In all they included thirty-five articles, which they assessed for associations with physical factors at work, psychosocial factors at work, and individual factors. Of the 19 cited studies reporting on associations between back disorders and lifting or carrying of loads (LFM), sixteen were positive. The risk estimates ranged from 1.12 to 3.07, with attributable fractions estimated between 11% and 54%. Nine out of ten studies reported positive associations with frequent bending or twisting of the trunk (BT), three of which reported exposure-response relationships. Seven studies examined heavy physical load (HPW); six of these demonstrated increased risks of 1.54 to 2.58; however the one large longitudinal study did not demonstrate an association between physical load and the incidence of back injury claims during the study period (Ex. 26–1242). For static work postures (SWP), seven studies were considered and three of these had positive associations, The authors found some evidence of an association between the psychosocial factors of job dissatisfaction and low job decision latitude and back pain, but the evidence was not consistent across different studies and study designs. The review found that age, smoking habit, and education may be important confounders, while the individual characteristics of gender, height, weight, exercise or sport, and marital status were consistently not associated with back disorders. The finding that exercise or sport, the one physical individual characteristic examined, was not associated with back disorders provides supporting evidence that the physical work-related risk factor findings are real and are not confounded by leisure time physical factors.

In making their causality determination, Burdorf and Sorock acknowledged that the majority of cross-sectional design studies in the data base precluded a firm determination of the temporal and specificity criteria of the Hill criteria; they also expressed some concern that ''the state of the art does not allow unequivocal conclusions about the contribution of specific work-related risk factors to the incidence of back disorders.'' (Ex. 500–71–24, pg. 253). Nevertheless, they concluded that:

Despite these methodological concerns, the available literature has presented persuasive evidence for several risk factors for work-related back disorders. Various studies with clear differences in design, methodology, and populations have consistently produced comparable findings for MMH, frequent BT, heavy physical load and WBV. With regard to MMH, sufficient biomechanical and physiological evidence is available to support the biological plausibility of lifting as a risk factor for back disorders. The results on lifting do not distinguish between the effect of infrequent lifting of heavy loads and frequent lifting of light loads. The studies among nurses indicate that a single lift of a patient is associated with an increased risk of back pain or back disability [cite to Exs. 500–41–92, 500–41–70, and 500–41–49]. This finding is consistent with biomechanical evaluations that predict high compression forces on the lower back during patient lifting [cite to Ex. 38–141]. Frequent BT of the trunk was consistently related to back disorders in various studies. In one case-referent study with detailed exposure assessment, a clear dose-response relationship was shown [cite to Ex. 26–39]. The findings for heavy physical load demonstrate that this is an important work-related risk factor. Several community-based studies have presented dose-response gradients [cite to Exs. 29–959, and others]. The strength of the gradients is difficult to assess since self reports have been applied to rank exposure to physical load on ordinal scales. A second problem is that this particular risk factor probably includes MMH and frequent BT. Hence, in epidemiologic surveys, heavy physical load might be a surrogate measure for other risk factors rather than a separate risk factor (Ex. 500–71–24, pg. 253).

Finally the review concludes:

This review concludes that there is a clear relationship between back disorders and physical load, that is, between back disorders and MMH, frequent BT, HPW, and WBV. * * * the evidence presented indicates that preventive measure reducing the exposure to these risk factors will decrease the occurrence of back disorders.

Hoogendoorn *et al.* (1999, Ex. 500–71–32) conducted systematic reviews of the literature for physical load as risk factors for back pain. A rating system was used to assess the evidence based on methodological quality and consistency of the findings; under this scheme cross-sectional studies were excluded based on the authors' quality criteria. The review of studies addressing physical load examined 28 cohort and 3 case-referent studies. For physical load, the review found that strong evidence exists for work-related MMH, BT, and whole-body vibration as risk factors for back pain. Moderate evidence exists for patient handling (LFM) and HPW, and no evidence was found for standing, walking, sitting, sports, and total leisure time physical activity.

OSHA finds that the consistency of findings in the NIOSH 1997 (Ex. 26–1) and the two other recent reviews, all using different study selection and evaluation criteria, provides confirmation of OSHA's emphasis on NIOSH's methodology and conclusions for work-related causes of back pain. The assessment on physical load factors was insensitive to slight changes in the assessment of findings and the methodological quality of the studies. Burdorf and Sorock (Ex. 500–71–24), in their review, also commented that comparable findings were consistently found for heavy physical work, lifting, twisting and bending, and whole body vibration at work in various studies with clear differences in design, methodology, and populations.

Dr. Tapio Videman's Testimony on Twin Back Studies

Dr. Tapio Videman, DrMedSci, University of Helsinki, testified that a weakness with the OSHA proposal was that in the studies OSHA examined, the role of genetic factors was not taken into account in studies estimating the effect of work-related stress factors (Tr. 16996). To make this point, Dr. Videman presented a slide in his testimony (Tr. 16997) that referred to a published paper he had co-authored on the determinants of lumbar disc degeneration in a retrospective cohort study (Ex. 26–71). The study design attempted to control for the role of genetics by comparing disc degeneration scores between identical twins with different exposure factors thought to be associated with back pain. Among the factors examined in the paper were occupational workload, leisure time physical activities, measures of aerobic exercise and other sports participation, occupational driving, and smoking.

The study consisted of 115 pairs of identical twins selected from the Finnish Twin cohort, who were among the most discordant pairs in terms of the exposure factors mentioned above. The objective was to study whether differences in exposure factors correlated with the disc degeneration scores, controlling for genetic factors. Both observational and digital summary scores for disc degeneration, based on an MRI examination, were obtained for both the upper and lower back regions. Occupational and leisure physical activity responses were derived via personal interviews.

An important feature of the study design is that of the 115 pairs of twins only 23 pairs were discordant for heavy work before the age of 20. Also, based on a job scale rating of 1 to 4 to aggregate every job title and associated task descriptions during a subject's lifetime work history, the mean absolute job scale difference in these 115 twin pairs was 0.9. For mean hours working in bending/twisting positions the absolute mean difference within the 115 pairs was 1.6 hours. This means that this study had little statistical power to show differences among physical work factors, after adjusting for genetic factors, since only discordant pair results factor into an individual matched analysis.

The authors examined the associations between the several exposure factors and disc degeneration scores using both univariate and multivariate analyses, and both observational and digital summary scores for disc degeneration for both upper and lower bask disc degeneration scores. In the univariate analyses, which apparently did not factor in the twins matched pair design, only the heavier physical work job code score and mean total occupational lifting per day were significantly adversely associated with disc degeneration score, and then only for the high back discs. Most other increased physical activity and smoking scores were also associated with increased disc degeneration scores, but the associations were not statistically significant. Increased mean time sitting at work was associated with less disc degeneration for both high and low back, but only the high back scores showed statistical significance.

To attempt to control for the genetic effect, the authors also used multiple regression methods in an attempt to explain the observation summary disc scores. Their results found that, for the upper back, only the mean job code and age were jointly statistically significant, with no other specific environmental or behavioral factors contributing significantly. For the lower back, heavy leisure time physical loading was the only specific environmental factor of statistical importance; this one variable explained 2% of the variance in the multiple regression model.

In an attempt to consider the amount contributed by the genetic component in the study design, the authors inserted 114 co-twin (indicator) variables in the model and recalculated the estimates. They found that together, these 114 variables, ''those of familial aggregation, reflecting primary genetic and shared early environmental influences * * * explained nearly 75% of the variability in disc degeneration score in the upper region and nearly 50% in the lower lumbar region (*id.,* pg. 2608). The authors concluded, as did Dr. Videman in his testimony, that these ''findings suggest that disc degeneration may be explained primarily by genetic and early environmental influences and unidentified factors. * * * If disc degenerative changes are associated with symptomatic conditions, these studies findings suggest a need to rethink future research and prevention strategies in this area.'' (*id.,* pgs. 2610–2611).

Dr. Videman and associates made similar findings on the importance of genetic factors in disc degeneration in a study comparing 20 pairs of twins with discordant smoking status (Ex. 32–241–3–89; Tr. 16994–16995). Using the same type of multivariate methodology, with one variable for smoking and 18 variables for co-twin status, they concluded, ''Whereas smoking status and age explained 0 to 15% of the variability on the various degenerative findings in the discs, 26% to 72% of the variability was explained with the addition of a variable[s] representing co-twin status. These findings are compatible with a marked genetic influence and warrant further investigation.'' (Ex. 32–241–3–89).

In his testimony at the hearings, Dr. Videman emphasized the relative importance of genetic factors over physical work factors, ''(W)e could conclude that, from a blood sample, I can predict MRI [disc] changes better than having a lifetime work history about another interview.'' (Tr. 16998).

OSHA has considered Dr. Videman's testimony and publications and disagrees with his conclusions about the relative importance of physical work factors and genetics in the prediction of MRI disc changes. Although the agency agrees that the discordant identical twin study design is useful to control for genetic and early environmental factors, other factors in the design are at least as important. As was seen in the first study discussed above (Ex. 26–71), in a matched control study the amount of discordance in the exposure variables within the twin pairs will determine the power of the study to detect an effect. For example, with little discordance in exposure variables and few discordant pairs, the study has little ability to detect a true effect. In fact OSHA believes that in such a situation degenerative disc summary scores between twins should be very similar. To carry this example further in that first study, which involved the 115 twin pairs with little co-twin difference in the exposure variables, it is not surprising that adding 114 co-twin variables to the analysis, it is absolutely no wonder that in total these 114 variables will explain most of the variation in the multiple regression model. OSHA concludes that Dr. Videman's conclusion on the importance of genetic factors in his studies is a function of his analysis and his study design. This type of matched-control study is designed to control for genetic effects, not to study them.

OSHA also notes that in Dr. Videman's smoking study with 20 twin matched-pairs and a mean discordance between siblings of 32 pack years, ''a very huge difference'' (Tr. 16994), the disc degeneration difference was statistically significant at all of the measured disc levels. Controlling for genetic traits was undoubtedly important, as suggested by the statistical significance of the 18 covariables (Ex. 32–241–3–89, pg. 1666).

In the hearings, Dr. Videman was questioned by Ms. Seminario about a study he co-authored that concluded, ''environmental factors [including physical work factors] account for more than 80 percent of the [etiology] of sciatica and more than 90 percent in the case of patients admitted to the hospital.'' (Tr. 17054, see also Dr. Videman's response to a similar question by Ms. Butterfield, Tr. 17128). Although Dr. Videman acknowledged the correctness of this statement, he appeared to contradict these findings by explaining that ''all the data from that study was based on questionnaire data, so the reliability of the diagnosis is unclear.'' (Tr. 17129). OSHA notes, however, that in the actual paper the authors note that ''the cumulative age-specific incidences of sciatica [were] based on both the questionnaire and the hospital discharge records,'' and that the results are in ''accord with the results of a previous Finnish study.'' (Ex. 502–227, pg. 397). Furthermore, the authors noted that the hospital discharge diagnoses are given by doctors based on the WHO manual of the International Statistical Classification of Diseases (*id.,* 394). The authors also cited studies on the reliability of the nationwide hospital discharge registry (id., 394).

Thus, because that Dr. Videman's conclusions about the relative importance of genetics and physical work factors in back disorders were based on the questionable methodology used in the two twin studies discussed above, and because Dr. Videman's testimony on another study which contradicted those conclusions was not supportable, OSHA is unable to give much weight to Dr. Videman's testimony on this issue.

The Bigos et al., 1991 Back Study

Bigos *et al.*published several papers on a study (see, *e.g.,* Exs. 500–121–8, 38–280, 26–1241) that assesses the role of work perceptions and psychosocial factors in predicting the report of back pain disability. The study group was a cohort of aircraft assembly workers at the Boeing Company in Everett, Washington who volunteered to participate. This longitudinal study ultimately analyzed 1326 out of a cohort of 4027 aircraft assembly workers (33% of the original solicited population) for the final models.

The health outcome studied was ''back pain disability lasting longer than 3 months,'' and the authors used three notification systems—reporting to the company medical department, filing an incident report, or filing an industrial insurance claim. The study did not investigate the actual presence of back symptoms or specific back disorders. At the beginning of the study, subjects answered a series of questionnaires which addressed demographics, psychosocial factors, and cardiovascular risks, as well as a take-home questionnaire including the 566 question Minnesota Multiphasic Personality Inventory (MMPI), the Health Locus of Control Questionnaire, and a modified Work Adaptation, Partnership, Growth, Affection, and Resolve (APGAR) survey (modified from the Family APGAR survey). Other information included previous medical history, previous back discomfort or problem, back injury claims in the previous 10 years, and work perceptions. Subjects were also given a physical examination to assess physical attributes including anthropometry, lifting strength, aerobic capacity, and sagittal flexibility. A back examination including reflexes, girths, sciatic tension, and posture was performed. Thus, each subject provided individual responses to questions concerning these physical and psychosocial factors.

In contrast to the above factors, which were collected for each worker individually, workplace exposure assessment was limited to all jobs that employed more than 19 workers and was not performed on individual workers. These jobs were analyzed for tasks that were heavy and tiring tasks in terms of maximum loads on the spine, based on some unspecified biomechanical mathematic model. Any worker in a job with fewer than 19 people did not get physically measured; also, the authors did not measure workers' cumulative loads. As with the psychosocial factors, workplace exposure was also measured only at initial recruitment.

Subjects were followed for slightly more than four years, during which 279 subjects reported back problems. After analyzing the data to determine which factors could best predict these reports, the authors concluded:

Other than a history of current or recent back problem, the factors found to be most predictive of subsequent reports in a multivariate model were work perceptions and certain psychological responses. * * * Subjects who stated that they ''hardly ever'' enjoyed their job tasks were 2.5 times more likely to report a back injury (p=0.0001) than subjects who ''almost always'' enjoyed their job tasks. These findings emphasize the importance of adopting a broader approach to the multifaceted problem of back complaints in industry, and help explain why past prevention efforts focusing on purely physical factors have been unsuccessful.

OSHA notes that one major problem with the interpretation by other researchers of these results in the Boeing studies is that within the Boeing studies, ''physical variables'' include only those physical attribute variables that deal with anthropometry, back examination indices, and physical capabilities (*e.g.* flexibility, lifting strength, aerobic capacity) (Ex. 38–280, Table 1, pg. 25). It is under the ''nonphysical variables'' that the authors included workplace factors—duration of employment, job classification code, and measured peak spinal loading—as well as psychological and psychosocial factors. Other researchers include workplace factors (*e.g.,* measured peak spinal loading and physical workload) as physical variables. Thus, when Bigos *et al.*conclude in their study that none of the physical variables was important in predicting back pain reports (back disability > 3 months)—they are not referring to the same types of work-related physical risk factors—lifting/forceful movements, bending/twisting and awkward postures, heavy physical work, or static work postures—that OSHA refers to in its standard. Bigos *et al.*did not directly address these factors in their study.

OSHA also notes that the overall participation rate for this study was low, which makes representativeness an issue, especially for the 25% of the group that initially chose not to participate. The longitudinal study ultimately analyzed 1326 out of a cohort of 4027 aircraft assembly workers (33% of original solicited population) for the final models. In an attempt to determine whether the voluntary aspect of the study would create a bias, the authors compared the reported injury rates for those who returned incomplete data (n=1451) on their modified APGAR and MMPI packets, with the 1,569 subjects who did complete the forms. The difference in injury report rates was not statistically significant, which suggests that this final study group may be representative of the total.

OSHA also notes that no individual exposure measurements were carried out, although extensive individual psychosocial and psychological measurements were done. Workplace exposure assessment was limited to jobs that employed more than 19 workers, and there was no accounting for individual inter- or intra-variability. Because the exposure data represented the ''exposure'' of a group of workers rather than the measured exposure of individual workers, the authors would not be able to determine the contribution of physical factors to the observed outcome in as robust a fashion as they would the contributions of medical history, psychological surveys, physical exam, or job satisfaction survey, which were all recorded as individual exposure data. The authors did not report nor provide information on the analysis of the exposure data. There was no report on the data collected on biomechanical loads of the spine. They also did not report nor provide information on the data collected on the workers' perceived physical exertion in their jobs.

Dr. Bigos, in his testimony to OSHA during the hearings, stated that the Schultz model (the only biomechanical model related directly to human intradiscal measurements) was applied to the evaluation of mechanical stress on the Boeing subjects, and it found no significant relationship between mechanical stress on the subjects and the report of back problems or disability (Tr. 6725–6727). OSHA is addressing back pain in its final standard, and intradiscal measurement changes, obtained from the Schultz model, are not directly relevant to the existence of back pain or back disability.

OSHA also notes that this study did not address heavy lifting, or even jobs at the moderate or high end of HPW exposure. Bigos *et al.*report, ''the study was done in a diverse, highly sophisticated manufacturing industry where job tasks do not tend to be extremely stressful for the back.'' (Ex. 500–121–8, pg.5). As Bigos *et al.*(1991, Ex. 26–41) state, ''our study may not be representative of workers with extremely physically demanding jobs, where virtually no one remains active until retirement age.''

OSHA also has concerns about the interpretation of the results of the ''Work'' Adaptation, Partnership, Growth, Affection, and Resolve (APGAR) survey score. The authors added two additional untested items to the family APGAR: (1) ''I enjoy the tasks involved in my job,'' and (2) ''please check the column that indicates how well you get along with your closest immediate supervisor.'' (Ex. 26–1242, pg. 2). Results found the strongest statistically significant relationship between back disability and statement (1) ''I enjoy the tasks involved in my job.'' (id., pg. 3). However, this single initial response from a single point in time, rather than from more reliable repeated measures over time, was used to explain the outcome over a four-year period.

OSHA also has some concerns about a potential bias due to subjects who were excluded from strength testing if current back symptoms were present at the time of testing, or had caused them to miss work in the previous six months. This strongly influences the ability to draw from the study conclusions that are related to this variable, *i.e.,* eliminating the back pain subjects from the study population creates a healthy worker effect, which would bias results toward the null.

For the final predictive model, involving 33% of the original solicited population, the percentage of the overall variability explained by the model was 2.2% for job satisfaction, 1.9 for psychological factors, 1.2% for physical examination factors, and 3.3% for medical history; the sum of these individual components was 8.6%; 7% combined (Ex. 38–280, pg.29). This means that 93% of the variability was unexplained by this model for predicting industrial back pain reports (back disability > 3 months).

In sum, with the qualifications discussed above, OSHA acknowledges the importance of the Bigos *et al.*prospective study on the role of psychosocial factors in reports of back injuries. OSHA used this study in its weight of evidence determination for HPW as a risk factor for LBP, and found no association. However, OSHA concludes that physical risk factors were not as well determined in this study as were the psychosocial risk factors, making their relative contributions difficult to assess. Furthermore, the lack of truly HPW, according to the authors, among these workers would further limit the ability to study this physical risk factor. Thus, OSHA concludes that although this study found a significant relationship between psychosocial factors and LBP, this study lacked the ability to concurrently study the relative contribution of the physical work-related risk factors of interest to OSHA. In Section G5 OSHA provides additional discussion of both the Bigos *et al.*study and psychosocial risk factors.

Biomechanical Factors and Laboratory Experiments

For a distilled summary of the literature describing laboratory experiments and biomechanical models of risk factors associated with low back pain in table format, see Table II–1 in the health effects appendices to the proposed rule (Ex. 27–1).

There is some debate as to the exact etiology of low-back pain, and some authorities suggest that it is possible to make a precise diagnosis in perhaps only 20% of patients presenting with acute low-back pain (Frymoyer 1988, Ex. 26–118; Nachemson 1976, Ex. 26–1147; White and Gordon 1982, Ex. 26–1160). Proposed etiologies for low-back pain that have been advanced include the roles of nerve compression, tissue ischemia, sensitization of nerve endings, inflammatory mediators, spinal instability, and other postulates (Frymoyer 1988, Ex. 26–118; Nachemson 1992, Ex. 26–490). The majority of cases of work-related low-back pain are attributed to mechanical causes, such as muscle and ligament strains and sprains and disc herniations. Degenerative disc or facet disease, spinal stenosis, spondylolisthesis and compression fractures have also been attributed, at least in part, to work. Additionally, back disorder is multifactorial in origin and may be associated with both occupational and nonwork-related factors and characteristics (Bernard 1997; Ex. 26–1).

One additional difficulty in evaluating the etiology of low-back pain is that roughly 50% to 60% of patients reporting an episode of work-related low-back pain note an insidious onset of pain rather than a single, point-in-time event with immediate low-back pain (Bergquist-Ullman and Larsson 1977, Ex. 26–933). This study also found that cases with an insidious onset experienced prolonged recovery. Part of the explanation for this may lie in the absence of nociceptors in the disc itself and the facet joints (except for the synovial lining) (Pope *et al.*1991, Ex. 502–502). These load-bearing structures may, therefore, become injured without immediate recognition (*e.g.,* sudden pain), and the eventual manifestation of low-back pain may only occur after a series of point-in-time events have sufficiently injured these spinal structures to the point where nociceptors become irritated (*e.g.,* in the outer one-third annulus or facet synovium).

Specific Low-Back Disorders

Low-back pain symptoms are caused by a variety of injuries and disorders. Although the underlying cause of back pain cannot be determined definitively in up to 90% of patients, work-related cases are believed to result from the following mechanisms: muscle or ligamentous (soft tissue) injury; herniation of the intervertebral disc with irritation of adjacent nerve roots; and degenerative changes (arthritis/spondylosis) in the intervertebral discs (Deyo, Rainville, and Kent 1992, Ex. 26–365). Evidence for work-relatedness for low-back disorders of these three sources of etiology is summarized below.

Soft Tissue/Mechanical Low-Back Disorders

As noted earlier, the exact etiology of low-back pain is unknown in many cases, and therefore, there is a lack of universal agreement on the contribution of muscle and ligament sprains and strains to work-related low-back disorders. In part, the difficulty in diagnosis relates to the inability to easily palpate deep low-back muscles, the lack of imaging information on low-back muscle disorders, and the absence of surgical pathologic specimens to evaluate.

However, in addition to an understanding of muscle anatomy, consideration of muscle function (static and dynamic loading), and repair mechanisms contribute to understanding the role of muscle and ligament sprains and strains in work-related low-back disorders.

Static Loading

In evaluating the pathogenesis of soft-tissue low-back disorders, there are considerations related to static and dynamic work activities. Simple maintenance of posture requires balancing of counteracting mechanical forces about the spine. Static loading affects muscle and connective tissue. During static trunk flexion, low-back extensor muscles must progressively increase their activity to maintain trunk flexion (Schultz *et al.*1982, Ex. 26–581).

Using myoelectric measurements, Andersson *et al.*(1974, Ex. 26–346) ascertained that activity of the erector spinae progressively decreased as the angle of the back rest advanced from 10 degrees of forward inclination to backward inclination. This results from a partial reduction of the lumbar spine load imposed by the upper body as the load is transmitted to the back rest (Andersson and Marras 1996, Ex. 26–412; Chaffin and Andersson 1991, Ex. 26–420). In addition, during unsupported sitting, the lumbar spine flattens, and the use of lumbar supports and back rests can reduce the loss of normal lordosis (Andersson *et al.*1979, Ex. 26–1553).

Using a back rest inclination of 110 degrees and a 4 cm lumbar support, the authors were able to demonstrate that lumbar posture could be similar to normal standing posture. Maintenance of adequate seated posture has further implications for the intervertebral disc, with lower intervertebral disc pressures noted during supported sitting as opposed to unsupported sitting (Andersson *et al.*1974, Ex. 26–346). Inadequate seating can contribute to the development of low-back pain. Individuals who sit in chairs that are too high and have their feet unsupported experience elevated pressure on the back of their thighs (Akerblom 1969, Ex. 26–522; Bush 1969, Ex. 26–455; Schoberth 1962, as cited in Chaffin and Andersson 1991, Ex. 26–420). Burandt and Grandlean (1963, Ex. 26–1569) observed the tendency of subjects in high seat pans to slide forward in their seats to support their feet, negating the benefit of a back rest.

Dynamic Loading

Dynamic loading of the lumbar spine has other implications for muscle and ligament. Stresses induced in the low back during manual materials handling relate to the load weight and the characteristics of the lift. As a result of their anatomic positions, large spinal movements are created from relatively small degrees of muscle shortening. Unfortunately, this results in the generation of relatively large muscle and joint forces, with potential for tissue overloading and injury. This could be particularly important during excessive or rapid movement (Andersson and Marras 1996, Ex. 26–412), or at the point of muscle fatigue.

A study by Hukins *et al.*(1990, Ex. 26–143) revealed that greater forces are exerted on ligaments as the speed of motion increases. In addition, elastic limits of the ligaments and disc may be exceeded (Adams and Dolan 1981, Ex. 26–1348). Bush-Joseph *et al.*(1988, Ex. 26–939) evaluated the effect of the speed of lifting on the external load moment. Subjects were asked to lift at slow, medium, and high speeds. There was a direct linear correlation between increasing speed of lifting and increased peak moment. Furthermore, a study by Marras and Mirka (1992, Ex. 26–982) revealed that muscles must generate a higher percentage of electromyographic (EMG) maximal activity to maintain a constant muscle force as the speed of trunk velocity increases with bending.

Both lifting frequency and load weight affect back muscle work capacity, in part related to fatigue. Using EMG assessments, Kim and Chung (1995, Ex. 26–858) observed that lifting at 10% of maximum voluntary isometric strength (MVIS) at a rate of 6 times a minute was more fatiguing than lifting at 20% MVIS at a rate of 3 times per minute.

Frequent loading of the lumbar spine with moderate to heavy weights can also cause general physical fatigue with elevation in heart rate and energy expenditure. Uncoordinated muscle activation that could result from local and systemic fatigue could then place other tissues at increased risk with continued lifting (Garg 1986, Ex. 26–121).

Postural Issues

Additional postural factors during lifting significantly affect muscle function and risk of injury. Skeletal muscle is more likely to rupture during eccentric contraction (Friden and Lieber 1994, Ex. 26–546), a factor involved in many manual materials-handling tasks. In addition, muscle length affects the amount of force that muscle can generate, with maximal force produced when muscles are at their resting lengths (Andersson and Marras 1996, Ex. 26–412; Chaffin and Andersson 1991, Ex. 26–420). Therefore, lifting in positions where skeletal muscles are elongated or shortened can increase the risk of injury to these tissues.

Using EMG evaluation of muscle function during lateral flexion of the lumbar spine, Andersson, Ortengren, and Herberts (1977, Ex. 26–1570) demonstrated increased activity on the side contralateral to bending. Other researchers have determined that asymmetric loading in lateral flexion and axial rotation causes high levels of antagonistic activity in abdominal and back extensors. This is associated with increased myoelectric activity on the side of spine contralateral to the load, although there is still significant activity on the ipsilateral side (Astrand 1987, Ex. 26–527; Kelsey 1975, Ex. 26–1134; Magora 1970, Ex. 26–297; Merriam *et al.*1983, Ex. 26–299). Andersson (1977, Ex. 26–449) noted that increased intervertebral disc pressure and intraabdominal pressure occurs when the trunk is loaded in lateral flexion and axial rotation, with rotation being the greater factor.

Muscle Velocity and Acceleration

Marras (Ex. 26–1412) has indicated that several trunk muscle characteristics and demands associated with dynamic lifting may better assess the risk of developing a low-back disorder from manual materials handling. The authors analyzed 400 lifting jobs in 48 industries using a triaxial goniometer (Lumbar Motion Monitor or LMM) that was worn by working subjects. A combination of five trunk motion and workplace factors was able to reasonably predict jobs posing high risk for low-back disorders (Marras *et al.*1995, Ex. 26–1412). These factors include the lift frequency, load moment, trunk sagittal range of motion, trunk lateral velocity and trunk twist acceleration (Marras *et al.*1995, Ex. 26–1412). A recent NIOSH Health Hazard Evaluation provided additional verification that the LMM has predictive capacity equal to the NIOSH Lifting Equation in job analysis (NIOSH 1993, Ex. 26–521), with perhaps greater ease of administration.

Recently, Marras *et al.*(1990, Ex. 26–1523; 1993, Ex. 26–170; 1995, Ex. 26–171) studied the trunk angular motion characteristics of normal and chronic low-back pain subjects. Used in a clinical setting, the LMM appears to have good ability to accurately distinguish between normal individuals and those with chronic low-back pain or structural disease. The authors used anatomic and pain categories previously selected by the Quebec Task Force Study on Spinal Disorders (1987, Ex. 26–494). Normative trunk motion values for age and gender were derived in a study of 339 males and females from ages 20 to 70 years who had never experienced significant low-back pain. While wearing the LMM, subjects performed trunk flexion and extension in five symmetric and asymmetric motion planes (0 degrees, 15 degrees and 30 degrees right and left) while trunk angular position, velocity, and acceleration were recorded with the LMM. In a repeatability study, 20 healthy normal subjects who had never experienced a low-back disorder were tested with the LMM once a week for 5 weeks. No statistically significant differences were observed among the trunk motion characteristics between the five weekly test sessions using multivariate analysis of variance. Correlation coefficients were computed to select reliable trunk motion variables to be used in the next phase of the study. Correlations varied as a function of the angle of asymmetry and measured variables, with motion characteristics in the zero plane demonstrating correlation coefficients of 0.88 to 0.96 (number of conditions performed, twisting range of motion, sagittal range of motion at 0 degrees, sagittal extension velocity at 0 degrees, sagittal extension acceleration at 0 degrees, continuous velocity, continuous acceleration, lateral right range of motion at 0 degrees).

In the next phase, the eight highly reliable trunk motion characteristics evaluated in the healthy subjects were compared with measurements in subjects with chronic low-back pain (96 males and 75 females) who were recruited for study from secondary and tertiary referral practices. These individuals had been symptomatic for at least 7 weeks and had been sufficiently studied, including with appropriate imaging studies, to permit accurate Quebec classification. Dynamic trunk motion characteristics were normalized for age and sex, and using quantitative discriminant analysis, the 510 subjects were correctly classified in 94% of cases as being either healthy or having chronic low-back pain(stage-one analysis).

In a stage-two analysis, nine variables (the eight previously mentioned and continuous position) correctly classified 80% of subjects into one of eleven groups (normal, low-back pain alone, low-back pain with proximal or distal radiation, disc herniation with high or low pain scores, spondylolisthesis, spinal stenosis, postoperative, nonorganic components, other) via modified classification using splines. It was also noted that trunk range-of-motion parameters commonly used to quantify impairment had poor ability to discriminate normal vs. chronic low-back pain, nor was it useful in classification. Furthermore, a characteristic pattern of recovery from low-back pain was noted, with normalization occurring first in range of motion followed by velocity and later acceleration of dynamic trunk motion. It was opined that the LMM's ability to quantify unloaded free-dynamic motion and account for the co-activation of additional structures (*e.g.,* internal and external obliques, lattissimus dorsi) affecting erector spinae function was in part responsible for its enhanced discriminating ability compared to alternate imaging techniques.

Disc Disorders/Disorders of the Three-Joint Complex (Disc and Two Facets) and the Nerve Root

The three-joint complex refers to the intervertebral disc and two facet joints. This complex permits the spine to absorb compression and resist torsion and shear, while permitting translation and rotation of the spine. Epidemiologic evidence suggests that work exposures involving heavy lifting or manual materials handling are associated with low-back disorders, including disc disorders (Bernard and Fine 1997, Ex. 26–1).

Excessive or repeated spinal loading and inadequate rest periods to permit repair mechanisms to function may be associated with biomechanical stresses that damage intervertebral disc cartilage endplates. This may then disturb metabolic transport, hastening the development of degenerative disc disease and disc herniation with secondary nerve root compression or inflammation.

Rowe (1971, Ex. 26–319) opined that up to 70% to 80% of recurring, chronic low-back pain will eventually be diagnosed as discogenic. Discogenic pain can include clear and consistent symptoms and signs expected with lumbar disc herniation and specific nerve root pathology, as well as chronic low-back pain associated with increased pressure in the intervertebral disc or degenerative disc disease. In patients with lumbar disc herniations, approximately 90% to 95% occur at the lower three intervertebral disc spaces (lumbar 3⁄4 disc or lumbar 4th nerve root, lumbar 4⁄5 disc or lumbar 5th nerve root, lumbosacral L5/Sl or sacral 1st nerve root) (Deyo, Rainville, and Kent 1992, Ex. 26–365). Increased compressive and torsional forces transmitted to the lower levels of the lumbar spine probably account for this observation. Peak incidence of lumbar disc herniation occurs in adults during the working years from ages 30 to 55 (Spangfort 1972, Ex. 26–502). The onset of symptoms may be acute, subacute, or chronic, and the relationship to a single lifting incident may not always be obvious (Berquist-Ullman and Larsson 1977, Ex. 26–933). Symptoms and physical findings depend on the location of the disc herniation and the degree of nerve compression.

An understanding of disc biochemistry and biomechanics assists in the understanding of the pathogenesis of work-related lumbar disc disorders. For ethical reasons the majority of observations on spinal tolerance have been derived from cadaver spines. However, in vitro and in vivo comparisons appear to validate these conclusions. There is a wide biologic variation in human disc and end plate tolerances (Brinckmann *et al.,* 1988, Ex. 26–1318) related to age, gender, genetics, prior injuries, and other factors. The maximum axial compressive force tolerated by the human cadaver lumbar spine has been measured by Brinckmann *et al.,* 1988 (Ex. 26–1318) to range from 2.1 to 8.8 kN (210 to 880 kg), with 30% fracturing at forces below 4 kN and 63% fracturing below 6 kN. Adams and Hutton (1982, Ex. 26–1379) studied cadaver discs from male subjects aged 22 to 46 years. The authors determined that most specimens could withstand an average of 10 kN on single loading prior to failure, usually at the end plate. In contrast, Bartelink (1957, Ex. 26–349) noted that discs were fractured from forces ranging between 1.6 and 6.7 kN, with a mean of 3.1 kN. The wide inter-individual variation in tissue tolerance makes it difficult to assign a single value of compressive force against which to engineer jobs to prevent lumbar disc.

When mechanical failure occurs, it is generally through the cartilage endplates (Adams and Hutton 1982, Ex. 26–1379; Armstrong 1985, Ex. 26–1070; Brinckmann el al., 1988, Ex. 26–1318; Erdil, Dickerson, and Chaffin 1994, Ex. 26–424) Disc height, spinal position, and frequency of bending appear to be risk factors. Creep results in loss of disc height, increased contact between load-bearing surfaces of the facet joints, diminished capacity to dissipate forces, and decreased ability of the spinal column to tolerate loading (Kazarian 1975, Ex. 26–379). Adams and Hutton (1982, Ex. 26–1379) observed maximal single loading tolerances of up to 10 kN; however, when the spines were flexed forward, 40% of discs prolapsed at an average of only 5.4 kN. Repeated lumbar spine loading can cause tissue fatigue with fracture at lower loads than the spine would tolerate for non-repetitive loading. Adams and Hutton (1985, Ex. 26–1315) determined that when repetitive loading was simulated, previously healthy discs failed at an average of 3.8 kN.

These studies support the clinical observation that the intervertebral disc is especially vulnerable when loaded in the flexed position or when subjected to repetitive loading. This becomes more significant when workers with lower tissue tolerance from prior injury, degenerative disc disease, or age lift at high rates for prolonged periods.

Armstrong (1985, Ex. 22–877) noted that small microtears most often occur in the region of the posterior elements of the annulus fibrosus and cartilage end plates. As noted, these are the areas subject to the greatest spinal compressive forces (Gracovetsky and Farfan 1986, Ex. 26–128; Hickey and Hukins 1980, Ex. 26–708; Pope *et al.*1991, Ex. 26–1296). With repeated lumbar spinal stresses and/or injuries, progressive microfractures in cartilage end plates and annular fibers (annulus fibrosus) may develop in the intervertebral discs (initially toward the center of vertebral bodies). This causes altered metabolism and fluid transfer with different mechanical behavior of the disc.

Eventually radial tears result in the development of degenerative disc disease and/or bulging. As a result of this damage, the capacity of the lumbar intervertebral discs to tolerate further compressive loads during lifting is altered. When these smaller tears extend and form complete annular tears, the nucleous pulposis can protrude (disc herniation) (Farfan *et al.* 1970, Ex. 26–113). Over time, sclerosis of cartilage endplates and altered disc loading can facilitate the development of facet arthropathy, osteophytic change, stenosis, or instability. Disc degeneration in combination with facet arthropathy may also lead to foraminal narrowing with resultant nerve compression and radicular pain. These observations are consistent with a cumulative trauma theory that could account for some types of low-back injuries and is supported by the research and opinions of other authorities (Erdil, Dickerson, and Chaffin 1994, Ex. 26–424; Pope *et al.* 1991, Ex. 502–502; Yong-Hing and Kirkaldy-Willis 1983, Ex. 26–405).

While many individuals with degenerative disc disease are asymptomatic, individuals with greater degrees of degeneration are at risk for low-back pain. In one study (Vanharanta *et al.* 1987, Ex. 26–225) 90% of subjects with severe disc degeneration experienced pain during discography, while only 23% of those without disc degeneration reported pain.

Arthritis/Spondylosis

Several studies have suggested a relationship between lumbar degenerative disease and work activities (*e.g.,* heavy work, repetitive lifting, and vibration). This association has come from both radiographic and pathological evaluations in association with work histories. One difficulty in these evaluations is the observation that lumbar spine x-ray changes are common, occurring in about 40% of all low-back x-rays (Rowe 1983, Ex. 26–699). However, the relationship of many x-ray changes with symptoms of low-back pain is unclear (Andersson 1981, Ex. 26–1480; Himmelstein *et al.* 1988, Ex. 26–962; Magora and Schwartz 1976, Ex. 26–389; Rowe 1963, Ex. 26–317; 1969, Ex. 26–318). Videman, Nurminen, and Troup (1990, Ex. 26–1023) noted an increase in vertebral osteophytosis in autopsy specimens from workers who performed heavy work. Of interest is that the heavier work exposures also were observed in association with increased rates of low-back disability.

Riihimaki *et al.* (1991, Ex. 26–966) performed a radiographic study of the lumbar spine in concrete workers and house painters. Lateral lumbar x-rays were obtained in 216 concrete reinforcement workers and 201 house painters aged 25 to 54 years. Disc space narrowing was noted 10 years earlier and spondylophytes 5 years earlier in the concrete workers. Risk ratios for the univariate effect of occupation on disc space narrowing was 1.8, and for spondylophytes it was 1.6. Potential cofounders such as age, prior back accidents, body mass index, and smoking had minimal effect. The authors concluded that heavy physical work with materials handling and postural loading enhances the degenerative process of the lumbar spine.

Wickstrom, Nummi, and Nurminen (1978, Ex. 26–1161) evaluated degree of lumbar flexion, presence of pain, and x-ray findings of degenerative disc disease in 295 concrete reinforcement workers aged 19 to 64 years. These workers commonly perform work involving spinal loading in stooped postures. Radiographic evidence of degenerative disc disease was noted in two-thirds of the 110 individuals with restricted flexion and in one-third of those (n=185) with normal flexion.

Kirkaldy-Willis (1983, Ex. 26–431) described a pathophysiologic spectrum of changes that lead to the development of lumbar spine degenerative disease. In the first phase, there are early and mild changes in the posterior complex, with facet synovitis, joint effusion, capsular stretch, and thickening. Inflamed synovium may become entrapped in the joint between the cartilage surfaces and initiate cartilage damage. Meanwhile, the intervertebral disc develops some circumferential tears in the annulus fibrosus. Tears in the periphery have at least some potential to heal because of the proximity to vascularity, but these deeper tears lack this ability by virtue of their distance from blood flow or metabolic diffusion. As these circumferential tears enlarge, they develop into large radial tears. As a result, the nucleus pulposus begins to lose proteoglycan and exhibits structural changes with grade 1 or 2 degenerative disc disease. Loss of water and disc height as well as a decline in annular resistance can cause increased compression forces on the facets. Individuals may be asymptomatic or have vague low-back pain. However, due to the lack of nociceptors in the disc and facet joints (except the synovium), a significant degree of degenerative disease may occur before pain develops. Lumbar disc herniation may occur at this juncture with symptoms and signs or radiculopathy.

In the next phase, the posterior joint capsule and annulus fibrosus develops laxity and instability. The intervertebral disc progresses to grade 2 or 3 degenerative disease. It may be possible to detect instability on dynamic x-rays. Subperiosteal bone formation, calcification of the ligaments, and capsular fibers manifest as peripheral osteophytes and traction spurs (Dupuis 1987, Ex. 26–1299) in an attempt to stabilize the motion complex (MacNab 1977, Ex. 26–1367). If laxity predominates over repair processes, the degenerative spondylolisthesis (facet laxity) or retrolisthesis (disc laxity) may occur (Dupuis *et al.* 1985, Ex. 26–108).

In the final phase, there is fibrosis of the posterior facet joints, loss of disc material (grade 3 or 4 degenerative disc disease), and progressive osteophyte formation (Wedge 1983, Ex. 26–1035). This increases the load-bearing surface of the three-disc complex, although it decreases motion and results in increased stiffness. The repair process may create narrowing of the central canal (central spinal stenosis) from facet arthropathy, disc bulging, and hypertrophy of the ligamentum flavum. Lateral stenosis may also result from facet arthropathy and osteophyte formation adjacent to the neuroforamina. Spinal stenosis is a diagnostic entity that has only recently been described. A few patients have congenitally small spinal canals; however, most present with this type of acquired spinal stenosis secondary to longstanding degenerative disease. Most patients first become symptomatic after 50 years of age (Turner *et al.* 1992, Ex. 26–1455). By virtue of its long-term degenerative nature, spinal stenosis is not often considered a work-related disorder; however, patients with spinal stenosis may present with co-existing lumbar disc herniation or other degenerative changes that have been exacerbated by work factors.

Conclusions

OSHA finds convincing evidence from the confluence of many investigation on biomechanical models, laboratory research and epidemiology studies that work related risk factors including (1) heavy physical work, (2) lifting and forceful movements, (3) bending, twisting and awkward positions, and (4) static work positions are causally linked to low back disorders and pain. Work often involves several of these risk factors concurrently and there is evidence that the first three of these factors may act together in a synergistic way to increase the risk. However, OSHA considers that each factor, by itself, can increase the risk of back disorder.

F. Disorders of the Lower Extremities

Work-related disorders of the lower extremities have not received the same scrutiny as those of the upper extremities and back. However, existing information from pathophysiology, epidemiological studies, and biomechanical investigations implicate physical work factors related to repetitive, forceful exertion and awkward posture to these disorders, especially osteoarthritis of the knee and hip. As more completely described in Health Effects Appendix III.D (Ex. 27–1), osteoarthritis is considered a disorder of the movable joints characterized by the disintegration of the articular cartilage that covers the end of the bones. The articular cartilage and subchondral bone that lies just beneath the cartilage provide opposing structures and surfaces that are matched in such a way as to allow transmission of joint loads at the lowest and most uniform pressures, (Meisel 1984, Ex. 26–1562).

The arthrosis process is thought to begin with disruption at the thin surface overlying the load-bearing cartilage (Meisel, 1984, Ex. 26–1562). This disruption results in progressive erosion of the cartilage layer and a joint surface less able to withstand normal loads and forces. Continual loading on the joint then disrupts the process of bone/cartilage repair and regeneration, leading to formation of marginal bone in the shape of spurs (osteophytes). The degenerative process continues until the cartilage has been completely destroyed; there is bone-on-bone contact, and the structural integrity of the joint is lost. The clinical manifestations are joint stiffening, pain and loss of movement (Meisel 1984, Ex. 26–1562).

It is well recognized that acute trauma can trigger osteoarthritis, but there is also evidence that less substantial, but repetitive, forces to the joints can lead to microfractures of the articular cartilage and subchondral bone. The disruption in structural integrity results in the onset of the degenerative changes described above (Radin *et al.,* 1994, Ex. 26–578). This process has been observed in animals subjected to repetitive impact loading of one or more limbs (Moskowitz, 1992, Ex. 26–1547). Damage to the joints in these animals involve fibrillation and splitting of the cartilage, evidence of chondrocyte activity as bone remodeling occurs, progressive erosion of the cartilaginous layer, and formation of osteophytes.

Other MSDs of the lower extremity that may be caused by physical work-related factors include bursitis and tarsal tunnel syndrome. Joint overuse may lead to bursitis, an inflammation of a fluid-filled sac or sac-like cavity that serves to reduce friction in a joint (Ex. 502–317). Repetitive use of the foot may be related to tarsal tunnel syndrome, a nerve entrapment syndrome of the lower extremity analogous to carpal tunnel syndrome in the wrists (Day 1996, Ex. 26–615).

In addition to acute and repetitive trauma, MSDs of the lower extremities have been linked with congenital abnormalities, underlying genetic or metabolic disorders, and chronic conditions, such as cancer, diabetes and collagen-vascular disease (Felson 1994, Ex. 26–544; Meisel 1984, Ex. 26–1562).

Epidemiological Evidence

Epidemiological evidence of an association between workplace factors and MSDs of the lower extremities was discussed in Health Effects Appendix I. A summary of the risk factors is presented in Table C–1 (for osteoarthritis of the knee) and Table C–3 (for the hip). Several work-related activities, such as squatting and kneeling for more than 30 minutes per day, were significantly associated (OR≥3) with osteoarthritis of the knee in a population-based case-control study (Cooper *et al.,* 1994, Ex. 26–460). This study also showed that a combination of these activities along with lifting loads greater than 25 kg (which places an additional load on the lower extremities) resulted in an even stronger association (OR≥5) with this knee disorder. Other epidemiological studies associated occupations such as construction work, farming, firefighting, laundry/dry cleaning, and manual labor, with knee osteoarthritis (Anderson and Felson, 1988, Ex.26–926; Vinguard *et al.,* 1991, Ex. 26–1500).

Three case-control studies reported positive associations between MSDs of the hip and work tasks involving biomechanical factors (Coggon *et al.,* 1998, Ex. 26–1285; Croft *et al.,* 1992, Ex. 26–1503; Vinguard *et al.,* 1997, Ex. 26–1617). One study found that jobs requiring lifting over 25 kg more than ten times in an average week for more than 20 years raised the odds of developing hip osteoarthritis (Ex. 26–1285). Farmers, mail carriers, firefighters, and meat processors were occupations reported to be significantly associated with hip osteoarthritis in a registry-based cohort study (Ex. 26–400). Repetitive kneeling, squatting, and lifting are all activities involving the biomechanical risk factors of repetition, forceful exertion, and awkward postures of the lower joints. Table V–8 summarizes some key aspects of these investigations, including: Occupations examined; biomechanical risk factors involved; whether or not exposures were directly observed during the study, whether the health outcomes were verified by medical tests, whether evidence provided of an exposure-response or other temporal relationship between the risk factor and outcome; and the measure of relative risk used along with the results of this measure.

In addition to the evidence previously reviewed, Table V–8 includes five additional studies submitted to the docket that address physical work factors and disorders of the lower joints, primarily the knee (Ex. 500–41–114; Ex. 500–121–44; Ex. 500–41–69; Ex. 502–317; Ex. 500–41–68; Ex. 500–121–18. Three of the studies examined the prevalence of knee disorders among carpet- and floorlayers who spend a substantial amount of time working in knee straining postures. Kivimaki (1992, Ex. 500–41–78) compared 96 floor- and carpetlayers to 72 painters with regard to disorders of the knee. An analysis of videotaped work tasks indicated that floor- and carpetlayers assume a kneeling posture in their job 42% of their work time, compared to 3% of work time by painters. Ultrasonographic examination indicated changes in the prepatellar or superficial infrapatellar bursa in 49% of the carpet and floor layers compared to 7% of painters. On a symptom questionnaire, the floor- and carpetlayers reported a significantly greater prevalence of bursitis in front of the knee cap, knee pain in a kneeling posture, sudden and intense swelling of the knee, aspirations of the knee, and injections to the knee than painters.

TABLE V–8.—SUMMARY OF EPIDEMIOLOGY STUDIES EXAMINING MSDS OF THE LOWER EXTREMITIES

Study	Job type studied	Physical factors	Exposure basis	Diagnosis/body part	Other attributes	Risk measure (95% CI)[1]
Kivimaki (1992) Ex. 500–41–78.	carpet laying; floor laying.	F/R/P	observation questionnaire.	questionnaire ultrasound/knee.		NR*
Jensen (1997) Ex. 500–41–69	carpet laying; carpentry.	F/R/P	questionnaire observation.	questionnaire radiology/knee.	exposure response	OR=1.5–6.4* (3.2–8.9)
Tanaka (1986) Ex. 502–317	floor laying; tile setting.	F/R/P	questionnaire	questionnaire knee	exposure response	PRR=1.1–5.0* (3.2–7.8)
Sandmark (2000) Ex. 500–41–114.	prosthetic knee patients.	F/R/P	questionnaire	surgery/knee	exposure response	OR=0.7–3.2* (2.0–5.2)
Cooper (1994) Ex. 26–460	general population	F/R/P	questionnaire	questionnaire X-ray/knee.		OR=0.8–6.9* (1.8–26.4)
Anderson (1988) Ex. 26–926	general population	F?/R/P	job title questionnaire.	questionnaire X-ray/knee.		OR=0.8–3.5* (1.2–10.5)
Vingard (1991) Ex. 26–1400	various occupations.	F/R?/P?	job title	hospitalization knee or hip.		RR=0.6–3.8* (1,2–12.1)
Coggon (1998) Ex. 26–1285	patients case/control.	F/R/P?	questionnaire	hip replacement		OR=1.0–2.1* (1.1–3.9)
Croft (1992) Ex. 26–1503	patients case/control.	F/R?/P?	questionnaire job title.	joint measurement/hip.		OR=0.8–2.5 (1.1–5.7)
Vingard (1997) Ex. 26–1617	patients case/control.	F/R/P?	questionnaire	hip replacement		RR=0.8–2.3* (1.5–3.6)
De Zwart (1997) Ex. 500–121–18.	Various occupations.	F/R/P	job title	questionnaire lower limbs.	temporal relationship.	NR*

F=forceful exertions; R=repetitive motion; P=awkward posture; ?=presence of risk factor unclear;
RR=relative risk; OR=odds ratio; PRR=prevalence rate ratio
*=p<0.05

[1] 95% confidence interval expressed for the upper end of the risk measure range.

Jensen *et al.* (1997, Ex. 500–41–69) conducted a larger cross-sectional study of knee disorders among current and former floor- and carpetlayers (N=133), carpenters (N=506), and compositors (N=327). Based on telephone interviews and video recording of work activities, the authors determined that floor- and carpetlayers spent 56% of their working time in knee-straining postures. Carpenters were reported to have spent 25% of their working time in such postures, while compositors did not spend any working time in knee-straining positions.

Response to a questionnaire revealed that carpenters experienced a significantly increased frequency of knee complaints within the last 12 months (OR=3.8, 95% CI: 2.7–5.5), within the last seven days (OR=3.6, 95% CI: 2.3–5.8), and for more than 30 days over the preceding 12 months (OR=2.5, 95% CI: 1.6–3.9) when compared to compositors. Floor- and carpetlayers, the highest exposed group, also reported a significantly increased frequency of knee complaints within the last 12 months (OR=6.4, 95% CI: 4.0–10.1), within the last seven days (OR=5.7, 95% CI: 3.3–10.1), and for more than 30 days over the preceding 12 months (OR=5.3, 95% CI: 3.1–8.9) when compared to compositors; the odds ratios reported for floor- and carpetlayers were uniformly higher than those reported for carpenters. Age, weight, body mass index, smoking, and sports activities were reported to have had no significant effect on the incidence of knee complaints. Among 50 floor- and carpetlayers, 51 carpenters, and 49 compositors who had radiological examinations of their knees, an increased prevalence of osteoarthritis was found in floor- and carpetlayers (14%) when compared to carpenters (8%) and compositors (6%).

A third cross-sectional study involving floorlayers by Tanaka *et al.* (1986, Ex. 502–317), and also reported by Thun *et al.* (1987, Ex. 26–60), examined the relationship between work activities involving strain on the knees and the development of knee disorders. Floorlayers (N=112) and tilesetters (N=42) who reported frequent kneeling in a survey questionnaire were compared to a group millwrights, bricklayers, and decorators (N=243) who did not commonly kneel.

The floorlayers reported more frequent bursitis of the knee (20% vs. 6%) and more needle aspirations of knee fluid (32% vs. 6%) than the millwrights and bricklayers. Tilesetters also reported bursitis (11%) and knee aspirations (31%) in excess of those reported by millwrights and bricklayers.

In this study questionnaire responses were compared to responses given by a representative sample of white males to standardized questions about symptoms of knee disease. When compared to sample, floorlayers, tilesetters, and millwright and bricklayers all reported a higher age-adjusted prevalence for each of the seven symptoms than the sample. This result suggests that the relative risk of knee disorders in the highly exposed groups may be understated when millwrights and bricklayers are the reference group since they may, themselves, be at increased risk relative to the general population.

Physical examination that included radiological tests of a subset of the workers was performed to validate the questionnaire. The questionnaire was reported to show low sensitivity (38–44%), but moderate specificity (82–89%), for both bursitis and arthritis.

Other studies examined the relationship between lower limb MSDs and physical work factors in more diverse occupational settings. Using a case-control study design, Sandmark *et al.* (2000, Ex. 500–41–114) compared individuals who had received prosthetic knee replacements due to osteoarthritis to control subjects to examine the relationship between lifetime physical load from work and the risk of knee osteoarthritis. A total of 625 individuals who had received prosthetic knee replacements due to osteoarthritis, and who were between the ages of 55 and 70 at the time of surgery were compared to 548 age- and gender-matched individuals randomly selected from the population of the same geographical area who had not reported osteoarthritis or other dysfunction of the knee.

Through telephone interview and written questionnaire, the subjects provided information on workloads from occupational and non-occupational activities, personal characteristics, and general health status. The duration and frequency of activities (*e.g.,* kneeling, sitting, number of stairs climbed) were computed for each individual. Subjects were then divided into three exposure groups: No or low exposure comprising the lower quartile; medium exposure comprising the middle two quartiles; and high exposure consisting of the top quartile.

Analysis of the data revealed that, among men, lifting at work (OR=3.0, 95% CI: 1.6–5.5), squatting or knee bending (OR=2.9, 95% CI: 1.7–4.9), kneeling (OR=2.1, 95% CI: 1.4–3.3), and jumping (OR=2.7, 95% CI: 1.7–4.1) were significantly associated with osteoarthritis of the knee. Individuals who had spent ten or more years in an occupation considered to involve high physical load on the knee were also more likely to undergo knee replacement due to osteoarthritis than those who had not worked in such occupations (men, OR: 2.5, 95% CI 1.7–3.6; women, OR: 2.5, 95% CI: 1.6–3.9). The analysis controlled for confounders such as age, body mass index, smoking, and sports activities.

The findings of Sandmark *et al.* (Ex. 500–41–114), Jensen *et al.* (Ex. 500–41–69) and Tanaka *et al.* (Ex. 502–317) indicate an exposure—response relationship between the frequency of work involving strain to the knees and osteoarthritis, bursitis and other signs of injury to this joint.

In a longitudinal survey study, de Zwart *et al.* (1997) (Ex. 500–121–18) investigated changes in musculoskeletal complaints among workers performing mentally demanding work (N=4686) and heavy physical work (N=7324). Job demands were determined by occupational title. Mentally demanding work was described as sedentary, while heavy physical work involved tasks such as lifting heavy objects, handling heavy tools, and stooping in combination with standing or walking. The subject groups were stratified by age (20–9, 30–9, 40–9, 50–9 years old). The occurrence of musculoskeletal complaints were compared between two surveys having a mean interval of approximately four years. No physical examination or examination of medical records was performed.

The incidence of musculoskeletal complaints of the lower limbs on the second survey was higher among those who had not reported complaints on the first survey for all age groups. However, the incidence was only statistically significant for the youngest three age groups. The authors concluded that younger and middle-aged employees develop musculoskeletal complaints as a result of exposure to heavy physical work, and that a healthy worker effect served to mask this effect for the oldest age group. Because of its prospective design, this investigation provides a temporal link between MSDs of the lower extremities and heavy physical work.

Lemasters *et al.* (1998) (Ex. 500–121–44) examined the prevalence and risk factors for work-related MSDs among carpenters. (N=522) who completed a questionnaire on musculoskeletal symptoms, work history, and psycholsocial factors. The symptom questions assessed if they experienced pain, numbness, or tingling in a particular body region.

Generally, as duration of employment increased, the prevalence of symptoms increased. An adjusted logistic regression analysis showed that duration of employment in carpentry for at least 20 years was significantly associated with work-related MSDs of the knees (OR: 3.5, 95% CI: 1.3–9.2). Carpenters who indicated they felt exhausted at the end of day experienced significant increases of work-related MSDs of the knees (OR: 1.8, 95% CI: 1.1–3.1). Having minimal influence over their work schedule was also reported to be a risk factor for work-related MSDs of the knees (OR: 2.3, 95% CI:1.2–4.1).

A subset of the subject group received a physical examination including examination of the knees. The authors concluded that reported disorders, including those of the knee, were significantly associated with positive findings upon physical examination.

An examination of the reliability of questionnaire responses was performed by Booth-Jones *et al.* (1998) (Ex. 500–121–9). Ten percent of the subjects examined by Lemasters *et al.* (1998) (Ex. 500–121–44) were subsequently randomly selected and administered the original questionnaire for a second time. All positive responses were categorized as ''yes'' answers and all other responses were categorized as ''no'' responses. Comparison of the results of the first and second administrations of the test indicated that the responses were largely consistent, with overall agreement reported to be 85.6%. This result provides a strong indication that the questionnaire responses examined by Lemasters *et al.* (1998, Ex. 500–121–9) are a reliable representation of the recollections of the subjects examined.

A significant concern when evaluating studies in which exposure measurements and health outcome are based on self-reports is the possibility of recall bias. Among the studies pertaining to the lower extremities that are described here, those of Sandmark *et al.* (Ex. 500–41–114), Jensen *et al.* (Ex. 500–41–69), Tanaka *et al.* (Ex. 502–317), and Lemasters *et al.* (Ex. 500–121–44) each depend to a greater or lesser extent upon the accuracy of self-reported exposures to ergonomic risk factors. Such self-reports have been criticized as being unreliable (Exs. 30–276, 500–118). Evidence submitted to the docket regarding the studies discussed above, while not eliminating concerns about the reliability of self-reports, generally support their accuracy.

The validity of self-reporting as a means of measuring knee-straining work postures was examined by Jensen *et al.* 2000, Ex. 500–41–68). Self-reports were compared to timed video recordings for 39 carpenters and 33 floorlayers. The carpenters and floorlayers were videotaped while working and, then immediately afterwards were requested to estimate the amount of time spent in knee-straining postures. A close association was reported between the observed and self-reported durations (Spearman's correlation coefficient: 0.88). While this report provides evidence that immediate self-reports are largely accurate, recall bias associated with self-reports of historical work activities remains a concern.

Biomechanical Evidence

Bhattacharya *et al.* (1985, Ex. 502–270) examined the biomechanical forces associated with different working postures involved in carpet installation when using a knee kicker. The knee kicker is a device consisting of a plate with a set of teeth in one end that grips the carpet while an installer kicks the padded end with a knee to stretch the carpet. A job analysis indicated that carpet installers spend approximately 75% of their time in a kneeling position, and use the knee kicker an average of 141 times per hour. Postures were reported to require near-maximum knee flexion. Knee-flexion angles at impact averaged about 58°, while normal daily activities involve less flexion (*e.g.,* sitting, 87°; tying shoe laces, 74°; walking upstairs, 97°). Workers performing the heaviest of the knee kicks produced peak impact forces averaging over 3000 newtons, equivalent to approximately four times their body weight. The authors suggested that the biomechanical demands of installing carpet may be responsible for the high incidence of knee disorders among these workers.

Conclusion

OSHA concludes that strong evidence is available showing that steoarthritis of the knee and other MSDs of the lower extremities can result from exposure to the combined physical work-related factors of repetition, force, and awkward posture. This evidence comes from the consistently positive associations in epidemiological studies of carpet- and floorlayers who spend considerable amounts of time in knee-straining postures. Biomechanical evidence indicates knee flexion and impact forces can be substantial during installation of carpet. Other occupational activities that involve excessive squatting, kneeling, and climbing stairs have also been shown to be associated with osteoarthritis of the knee and hip. Some studies indicate an exposure—response or temporal relationship between physical risk factor and health outcome. Therefore, it is biologically plaucible that repetitive impact loading on the joints is consistent with the degenerative pathophysiology of osteoarthritis. OSHA concludes that the evidence reviewed in this section demonstrates that workers who perform job tasks requiring repeated forceful flexion of the knee or other joints of the lower extremities are at increased risk of serious musculoskeletal impairment such as osteoarthritis.

G. OSHA's Response to Health Effects Issues Raised in the Rulemaking

1. Comments on OSHA's Use of the NIOSH (1997) and NAS (1999) Reviews

Several commenters (Ex. 30–1722; Ex. 500–109; Ex. 32–368–1; Ex. 32–241–4; Ex. 500–197) criticized OSHA's reliance on the 1997 NIOSH review (Ex. 26–1) and the 1999 NAS report (Ex. 26–37) of the evidence for work-related MSDs. First, the commenters considered the methodology used by NIOSH to evaluate the epidemiological evidence that work-related factors were associated with MSDs to be seriously flawed. Second, they accused OSHA of ignoring obvious limitations of the NIOSH review and then misrepresenting its conclusions. Finally, the commenters claimed that the NAS workshop report did not support the OSHA position with regard to biomechanical risk factors and MSDs. A more detailed description of each assertion will follow along with OSHA's response.

The criticisms of the NIOSH methodology were aimed at nearly every level of evaluation. It was said that NIOSH exercised a ''publication bias in favor of positive studies'' in its study selection (Ex. 500–197, pg. I–146). It was said that the NIOSH criteria used to assess study quality ''emphasize[d] biased and unreliable methodology at the expense of sound scientific approaches.'' (Ex. 32–241–4, pg. 109). It was said that there was ''no indication of any systematic method for assigning weight,'' (Id. pg. 109), and that the weighting could not be ''replicated and, therefore fails to satisfy one of the most basic tenets of scientific inquiry.'' (Ex. 23–109, pg. 23). It was said that NIOSH ''failed to adequately consider other confounding factors in their analysis'' (Ex. 32–368–1, pg. 40). Finally, it was said that NIOSH was ''forced to draw its conclusions from a larger body of literature that included studies meeting only some, or even none of these criteria.'' (Ex. 500–197, pg. I–148). One commenter summed up the NIOSH evaluation process as follows:

> The report did not conform to the generally accepted scientific methods for critical analysis. It did not use a weight of the evidence approach. For example, there is no explanation of how studies which met NIOSH's criteria standards were regarded differently than studies which did not. In essence, NIOSH put the 2000 studies into a black box, and out popped 600. Then the 600 went into another black box, and out popped the conclusions (Ex. 32–368–1, pg. 36–37).

OSHA strongly disagrees that the approach used by NIOSH to evaluate the epidemiological studies was flawed or that the conclusions in the 1997 review are weakly supported by the evidence. In the first chapter of its report, NIOSH describes, in detail, where it retrieved information on epidemiological studies, how studies were selected for more detailed review, the procedure used to analyze the overall strength of work-relatedness, the six criteria (strength of association, consistency, temporality, exposure-response, coherence, and role of confounders) employed to evaluate the evidence of causality, and the four categories to classify the evidence. The 600 studies reviewed by NIOSH [out of more than 2,000 identified in initial database searches] were published or accepted for publication in the scientific literature or government reports that had undergone peer review and were widely available. These had to meet some minimum requirement in terms of defined study groups, measurable health outcomes, identifiable exposures related to physical factors, and adequate study design. The NIOSH selection strategy was a common screening approach that has been successfully employed by OSHA and many other groups. There was no bias toward the selection of positive studies; rather NIOSH selected those only studies that met the above criteria. OSHA believes that the NIOSH selection process captured the best epidemiological studies available at the time on which to evaluate the evidence for a causal association between work-related risk factors and MSDs.

NIOSH analyzed the reviewed studies in terms of well-accepted epidemiological principles, such as participation rate, blinded study design, exposure method, and case definition and gave greater weight in its evaluation process to those that minimized selection and observation bias and confirmed the existence of exposure and health outcome by qualified experts. NIOSH applied the highly-regarded Bradford Hill criteria (see six criteria above) for judging the evidence for causation in classifying work-relatedness. These criteria were not applied to any single investigation but to the entire database of studies as a whole. NIOSH judged there was evidence of work-relatedness between biomechanical factors and MSDs when there existed convincing evidence from several studies for a causal relationship using the epidemiologic criteria, and for which chance, bias, and confounding factors were not the likely explanation. OSHA believes that NIOSH clearly did not use a ''flawed'' methodology and their evaluation process represents a systematic weight of evidence approach that relies on an unbiased set of sound and reliable scientific principles.

NIOSH concluded there was evidence that MSDs of the neck, shoulder, upper extremities, and back that have been subjected to epidemiological investigation were associated with at least some biomechanical factors or combination of factors. In several instances, the evidence was judged to be strong. For most MSDs, there were situations in which the epidemiological evidence was judged insufficient for certain biomechanical factors in isolation (*e.g.* CTS and extreme posture; epicondylitis and repetitive motion). However, these factors were usually found to be associated with the MSD when present in combination with other biomechanical factors (*e.g.* strong evidence of posture/force combination and CTS; strong evidence of repetition/force and epicondylitis). For several MSDs, OSHA found that the strength and consistency of the associations between biomechanical factors and MSDs was even stronger, if the evaluation was restricted to studies where exposure was directly observed or measured and the health outcome was confirmed by physical exam or medical tests (see Health Effects Section V). It is important to note that the NIOSH analysis focused primarily on the epidemiological evidence. OSHA believes these conclusions were reasonable and based on the selected evaluation criteria.

Since the evaluation process involved expert judgment, weighting of individual studies cannot be precisely ''replicated'' in the same way as a scientific measurement, however, substantial evidence in the rulemaking record supports NIOSH's conclusions. There were a number of written submissions and oral testimony from scientific experts supporting the position that sufficient evidence exists that biomechanical factors can increase the risk of MSDs (*e.g.,* Exs. 30–3805, 32–57, Tr. 9819, 16317, 17358, 17687). Some notable testimony on the epidemiological evidence from distinguished experts were as follows:

> There is a significant body of epidemiological and case study literature that indicate that a high rate of work-related MSDs, carpal tunnel syndrome, bursitis, tendinitis, and epicondylitis are significantly higher in jobs that involve repetitive motions, localized stress, awkward positions, vibrations, and forceful exertions.
>
> Dr. Robert McCunney (Tr. 17566–67)
>
> OSHA's conclusion that there is an epidemiological evidence of an association between many work factors and certain MSDs is consistent with the literature that I've read and my clinical experience as an occupational medicine physician treating thousands of patients with MSDs over the past 20 years.
>
> Dr. Michael Erdil (Tr. 1112)
>
> We have, first of all, lots of epidemiological studies that show physical factors are involved in MSDs. We have actually no epidemiological study that shows, that proves there is no physical factor involved.
>
> Dr. Niklas Krause (Tr. 1367)

Some commenters thought that OSHA misrepresented the findings from the NIOSH review in order to support its own conclusions that exposure to work-related biomechanical factors increase the risk of serious musculoskeletal impairment. It was claimed that OSHA had seriously overstated the NIOSH conclusions as ''having established causation'' (Ex. 32–241–4, pg. 98) between biomechanical factors and MSDs regardless of the length and intensity of exposure, instead of the true NIOSH goal of drawing conclusions about the evidence of an association between risk factor and health outcome under conditions of prolonged exposure. Commenters argued that OSHA ignored the restricted scope of the NIOSH analysis that was limited to ''certain objectively defined MSDs'' and ''examined only certain very specific stressors of highly repetitive and forceful work, lifting and forceful movements, awkward and prolonged sustained postures and exposure to vibration.'' (Ex. 500–109, pg. 24). On the other hand, it was claimed that OSHA used the NIOSH findings to ''support causal inferences for all other MSDs * * * which include not only those MSDs studied by NIOSH but also DeQuervain's disease, trigger finger, Raynaud's syndrome and tarsal tunnel syndrome'' and ''attempts to broaden the NIOSH exposure associations to include not only the factors that NIOSH studied, but also a wide range of other so-called ergonomic risk factors including among others, contact stress and cold temperatures.'' (Ex. 30–1722, pg. 43).

OSHA does not agree that the findings of the 1997 NIOSH review have been misrepresented in any way. The Agency has not stated that the epidemiological evidence established that MSDs are caused by exposure to work-related biomechanical factors. Epidemiological studies rarely, if ever, prove causation. They are designed to identify associations between two study variables. Depending on the strength and consistency of the associations and whether the association shows aspects of temporality and exposure-response, epidemiological data can provide evidence of a causal relationship. OSHA has stated that there is convincing scientific evidence that biomechanical factors, usually in combination, increase the risk of several specific MSDs. These conclusions are often based, not on epidemiological studies alone, but also on the pathophysiology of the disorder and biomechanical and psychophysical research that are able to link ergonomic risk factors to biomechanical and subjective measurements under a more controlled set of simulated work conditions.

In general, the conclusions drawn by OSHA based on the entire body of scientific evidence track closely with those of NIOSH. OSHA does not stretch the NIOSH findings ''far beyond the breaking point'' to support causal inferences of the existence of vast numbers of MSDs that are not examined by the epidemiological studies (Ex. 30–1722, pg. 44). For example, DeQuervain's disease and trigger finger are forms of hand tendinitis specifically examined in epidemiological studies (Ex. 26–48; Ex. 26–53; Ex. 26–897) relied on by NIOSH to conclude evidence of an association between repetition, force, and awkward posture and hand/wrist tendinitis. In fact, NIOSH states in its review that ''DeQuervain's disease and other tenosynovitis of the hand, wrist, and forearm have been associated for decades with repetitive and forceful hand activities as one of the possible causal factors.'' (Ex. 26–1, pg. 5b–8).

The other two MSDs cited as not being supported by NIOSH findings are Raynaud's phenomenon and tarsal tunnel syndrome (TTS). Raynaud's phenomenon refers to blanching of one or several fingers and is a characteristic sign of vascular damage that occurs in Hand-Arm Vibration Syndrome (HAVS) due to segmental vibration (Ex. 502–18). NIOSH concluded that there was strong evidence of a positive association between segmental vibration and the vascular symptoms of HAVS. TTS is an MSD of the foot and, therefore, was not addressed in the NIOSH review. However, it is a nerve impingement disorder analogous to CTS in the wrist. Like the carpal tunnel, the tarsal tunnel is a relatively ''tight'' compartment filled with flexor tendons and the tibial nerve that may be susceptible to compression in response to increases in intra-tarsal pressure as a result of repeated flexion/extension of the ankle.

In the Final Rule, OSHA does not broaden the set of biomechanical risk factors associated with MSDs beyond the four (force, repetition, posture, and vibration) supported by the 1997 NIOSH review (contact stress, which is covered by the standard, is a particular combination of force and repetition). Although OSHA believes that evidence exists that cold temperatures can aggravate some MSDs, this environmental factor principally operates to modify exposure to some of the biomechanical factors listed above and is not regarded as a primary risk factor. OSHA included contact stress in the final rule's Basic Screening Tool because there is reasonable evidence that repeated impact, such as hand hammering, increases the risk of the MSD known as hypothenar hammer syndrome (see Part D of the Health Effects section). In addition, repetitive knee hammering has been shown to be associated with a high risk of bursitis (''carpet layers knee'') (see Part F of Health Effects section). The final rule makes clear that it is prolonged and regular exposure to a combination of biomechanical work factors that presents the greatest potential hazard.

It should also be noted that workplace intervention is not required by the ergonomic standard unless there is an MSD incident that the employer has determined to be work-related and there is evidence of exposure to the biomechanical risk factors defined by the OSHA basic screening tool. This action trigger serves to limit the number of stressors and disorders that require action under the OSHA rule.

For the above reasons, OSHA finds that its conclusions with regard to work-related biomechanical factors and risk of MSDs do not misrepresent, but are entirely consistent with, the findings in the 1997 NIOSH review. This view was confirmed by written testimony from the Director of NIOSH, Linda Rosenstock:

> OSHA builds on the evidence of the association between workplace risk factors and the development of MSDs provided in the 1997 NIOSH review and strengthens the evidence with the supporting data provided by laboratory and psychophysical studies * * * NIOSH concurs with OSHA's conclusion from the discussion of the evidence from the epidemiological studies. OSHA concludes that ''In sum, although not all of the epidemiological studies reviewed demonstrate significant associations, the overwhelming majority justify a conclusion that the risk factors noted in this section, with effects adjusted by the four modifying factors, cause or exacerbate work-related MSDs.'' Thus the data justify the conclusion that these factors cause or exacerbate work-related MSDs (Ex. 32–450–1, pg. 7–8)

The commenters also claimed that OSHA misrepresented the findings of the NAS workshop and that the conclusions in their 1999 report ''simply do not support OSHA's broad conclusions linking physical work-related factors to musculoskeletal complaints.'' (Ex. 32–241–4, pg. 117). They allege numerous inadequacies of the workshop, such as the fact that the participants included ''only a few scientists who seriously questioned OSHA's ergonomic hypothesis'' (Ex. 32–368–1, pg. 33). Despite this, the workshop participants supposedly seriously questioned the NIOSH study and, unlike OSHA, ''admitted that the evidence of a link between MSDs and physical risk factors at the workplace is inconclusive at best,'' (Ex. 32–241–1, pg. 118). This led one NAS panelist, Dr. Howard Sandler, to state ''that the NIOSH approach to their review of the evidence was sufficiently flawed to make the conclusions questionable.'' (Ex. 32–241–4, p. 112). Presumably the NAS report ''actually undermines OSHA's decision to limit its analysis to physical, work-related factors'' since it cites ''individual, organizational, and social factors * * * which are possible influences on physiological pathways that lead from soft tissue to impairment and disability.'' (Ex. 32–241–4, p. 118). The argument for the OSHA misrepresentation of the NAS report is summarized as follows:

> In sum, the [NAS] Steering Committee advised *against* doing exactly what OSHA does in its analysis—focusing exclusively on physical work-related factors: ''Non-biomechanical factors *must* [emphasis added] be considered if understanding of the relationship between biomechanical work factors and MSDs is to expand and inform in the design of workplace interventions to reduce or prevent such disorders.'' (Ex. 32–241–4, p.120).

OSHA does not believe the NAS report seriously questions findings of the NIOSH review or undermines the OSHA position on the evidence that exposure to biomechanical factors increases the risk of MSDs. Regarding the epidemiological evidence, the NAS Steering Committee Report states:

> Restricting our focus to those studies involving the highest levels of exposure to biomechanical stressor of the upper

extremity, neck, and back and those with the sharpest contrast in exposure among the study groups, the positive relationship between the occurrence of musculoskeletal disorders and the conduct of work is clear. The relevant studies have not precisely determined the causal mechanical factors involved nor the full clinical spectrum of the reported MSDs (which are often lumped together nonspecifically as MSDs of a body region); nonetheless, those associations identified by the NIOSH review as having strong evidence are well supported by competent research on heavily exposed populations (Ex. 26–37, pg 15–16).

There is compelling evidence from numerous studies that as the amount of biomechanical stress is reduced, the prevalence of musculoskeletal disorders at the affected body region is likewise reduced. This evidence provides further support for the relationship between these work activities and the occurrence of musculoskeletal disorders (Ex. 26–37. p 16).

OSHA believes these NAS conclusions are not ''inconclusive at best'' but as the commenters claims, instead clearly support those associations between work-related biomechanical factors and MSDs identified in the NIOSH review where evidence is strong, namely combinations of forceful exertions, repetitive motions, awkward postures, vibration and heavy lifting. The above biomechanical exposures are the same ones that the OSHA standard seeks to reduce.

The NAS Steering Committee did point out some limitations to the epidemiological evidence, particularly that ''it was difficult to make strong causal inferences on the basis of evidence from any individual study.'' (Ex. 26–37, p. 15; emphasis added). They acknowledged that ''the occurrence of MSDs among populations exposed to low levels of biomechanical stressors was less definite. * * * In case of low levels of biomechanical stress, the possible contribution of other factors to MSDs is important to consider.'' (Ex. 26–37, p. 16). OSHA agrees with these statements and has not ignored the contribution of individual, organizational, and psychosocial factors in the etiology of MSDs. The Health Effects section of the rule emphasizes the multifactorial nature of MSDs. Substantial evidence in the rulemaking record, however, demonstrates that biomechanical risk factor show strong associations with elevated MSD risk when other non-work-related factors are controlled for. Thus, OSHA does not believe that the existence of other risk factors should prevent actions that reduce exposures to those work-related biomechanical stressors.

OSHA agrees that the majority of the NAS participants supported the ergonomic hypothesis that OSHA is espousing. This is not because the NAS selection process excluded those with other views, as implied by the commenters. The NAS prides itself on and is regarded world-wide as an organization that renders impartial and unbiased expert judgment on scientific issues. The reason for the NAS participants' support is simply that most ergonomic experts around the world agree there is clear evidence that biomechanical work factors increase the risk of MSDs.

OSHA is aware that one member of the six person panel addressing physical factors and epidemiology, Dr. Howard Sandler, was critical of NIOSH's methodology and findings. OSHA does not agree with Dr. Sandler's statements, and neither did the majority of the other panel members. In the NAS workshop summary, the consensus of the panel was that NIOSH had not overlooked any important body of epidemiological evidence. The panelists generally agreed that the NIOSH analysis resulted in the review on of high quality studies. With the exception of Dr. Sandler, the panelists unanimously agreed that a reassessment of the epidemiological literature would not alter the conclusions drawn by NIOSH regarding the work-relatedness of MSDs.

Finally, it is important to note that in evaluating all the evidence, not just the epidemiology, the NAS Steering Committee made the following conclusions:

Thus, while there are many points about which we would like to know more, there is little to shake our confidence in the thrust of our conclusions, which draw on converging results from many disciplines, using many methods:

- There is a higher incidence of reported pain, injury, loss of work, and disability among individuals who are employed in occupations where there is a high exposure to physical loading than for those employed in occupations with lower level of exposure.
- There is a strong biological plausibility between the incidence of MSDs and the causative exposure factors in high exposure occupational settings.
- Research clearly demonstrates that specific interventions can reduce the reported rate of MSDs for workers who perform high risk tasks. No single intervention is universally effective. Successful interventions require attention to individual, organizational, and job characteristics, tailoring the corrective actions to those characteristics (Ex. 26–37)

OSHA believes the above NAS conclusions support, not undermine, the premise that there is convincing evidence that exposure to work-related physical factors increases the risk of MSDs. There is a higher incidence of MSDs in exposed individuals; there is strong biological plausibility that relates these disorders to biomechanical risk factors; and interventions that reduce exposure to those factors have been demonstrated to reduce the incidence of the MSDs.

In summary, the methodology used by NIOSH to arrive at its findings that there is evidence of an association between a number of work-related physical risk factors and MSDs of the neck, upper extremity, and back is not a flawed ''black box,'' but a scientifically sound approach based on well-accepted epidemiological principles. By NIOSH's own testimony, OSHA's conclusions regarding biomechanical factors and the risk of MSDs in the workplace reinforce and do not misrepresent the 1997 NIOSH findings. Finally, the conclusions in the 1999 NAS report are supportive of both the NIOSH analysis and the OSHA position. In addition, to the NIOSH and NAS, the European Agency for Safety and Health at Work (Ex. 500–71–28) and Washington State (Ex. 500–71–93) have evaluated the scientific evidence and also reached similar conclusions regarding the evidence linking work-related biomechanical factors with the development of MSDs.

2. Issues Relating to Causal Inference in Epidemiology

Several commenters to the Proposal argued that OSHA had failed to show causality between exposure to workplace factors and MSDs; one group of comments emphasized that the types of studies used by NIOSH and OSHA to evaluate causality of the various MSD risk factors were inadequate for that purpose because of the studies design (see, *e.g.,* Ex. 32–241–4, pg 86–91). Specific comments were:

Only repeated longitudinal prospective studies can establish causation; OSHA relies instead on methodologies prone to error and bias. * * * Cross-sectional studies, upon which OSHA heavily relies, are incapable of providing evidence of cause and effect, because correlation does not establish causation (Id. pg. 86). Case-control studies are highly prone to bias. Prospective cohort studies are the best method of studying etiology, * * * retrospective studies [are prone to] the hazards of * * * ''recall bias.'' (Id. pg. 87). * * * In the case of musculoskeletal pain, which OSHA [has] linked to ''awkward postures'' and other biomechanical exposures, recall bias [in any retrospective design] can be extreme. * * * Cross-sectional studies are necessarily retrospective and prone to recall bias. (Id. pg. 87). [Cross-sectional studies] are useful for observing patterns and correlations, but can only generate hypotheses. A review seeking evidence of causation must exclude all cross-sectional studies, because their methodology is inadequate to test a hypothesis. (Id. pg. 88)

With respect to case-control study designs, the comments continued:

[C]ase-control studies generally measure exposure to various hypothesized risk factors retrospectively, and consequently are prone to a number of biases, particularly in the recall of exposure to suspected risk factors. * * * Case-control studies are most suitable for examining rare diseases * * * Musculoskeletal complaints are hardly ''rare,'' of course, making OSHA's reliance on retrospective studies particularly unwarranted and puzzling (Id. pg. 89).

With respect to combining studies for a total weight-of-evidence assessment, critics were somewhat divided. Some noted that:

[In order to do a proper assessment] only prospective cohort studies reliably establish etiology, that is, valid scientific evidence of cause and effect. (Id. pg. 89). * * * Adequate science, however, requires more than mere association. It demands clinically accepted, rigorously controlled studies. (Ex. 32–241–3–1, pg.3),

while others, including Dr. Stanley Bigos, felt that case-control studies could also be used:

To infer causal relationships, one would look for consistent findings in a number of case-control and prospective cohort studies, as well as other supporting scientific information. Bradford Hill published an influential set of guidelines for causal inference. (Ex. 32–241–3–4, pg. 9).

However, another commenter cautioned about drawing conclusions for a group of studies:

It should be noted that weaknesses of individual studies cannot be overcome by synthesizing a large number of studies with different weaknesses that suggest the same conclusion. (Ex. 32–241–4, pg. 89).

Still another commenter, Dr. Lloyd Fisher, noted a methodology using a statistical approach for combining studies. This methodology is termed meta-analysis:

The process for properly formally synthesizing information from multiple studies of the same thing is described in a textbook I coauthored. Requirements for a valid meta-analysis include that (1) *all* studies in the area be considered, without ''publication bias'' based on treatment effect indicated in the studies; (2) a careful assessment of study quality should be performed; and (3) study results should reflect a homogeneity of results. This was not attempted where possible in the material that I reviewed.

Perhaps the most notable example of meta-analysis discussed by OSHA is [the NIOSH report]. However, it is not clear that the NIOSH report satisfies any of the three conditions. Some relevant studies (such as the Boeing back-injury study) are not included. The quality of the studies is not directly assessed to any great degree. (Ex. 32–241–3–7, pg. 3).

OSHA has carefully considered these comments on the criteria and methodology for selecting and combining studies for a weight-of-evidence approach to evaluating causality and has concluded that OSHA's approach and the approach used in the NIOSH report (Ex. 26–1) are scientifically sound. First, with respect to the NIOSH methodology, OSHA notes that NIOSH did prioritize studies by type of design and did discuss each design's inherent capabilities, weaknesses, and potential biases (Ex. 26–1, App. A). NIOSH also included in its criteria for evaluating the weight of a study the study's population, health outcome, and exposure: ''the greatest qualitative weight was given to studies that had objective exposure assessments, high participation rates, physical examinations, and blinded assessment of health and exposure status.'' (Ex. 26–1, pg. 1–9 and 1–10).

NIOSH then evaluated the data base of studies using guidelines to assess causal inference made famous by Bradford Hill (Ex. 26–726). These consisted of (1) strength of association; (2) consistency of association; (3) specificity of association; (4) temporality; (5) exposure-response relationship; and (6) coherence of evidence (a combination of consistency with other information and biological plausibility). These guidelines are endorsed in the Reference Manual On Scientific Evidence (Federal Judicial Center, 2000) that assists federal judges in interpreting scientific reasoning as it pertains to litigation and is held up by Gibson, Dunn & Crutcher as an authoritative source. The *Manual* states the following about the application of the Hill criteria:

There is no formula or algorithm that can be used to assess whether a causal inference is appropriate based on these guidelines. One or more factors may be absent even when a true causal relationship exists. Similarly, the existence of some factors does not ensure that a causal relationship exists. Drawing causal inferences after finding an association and considering these factors requires judgment and searching analysis, based on biology, of why a factor or factors may be absent despite a causal relationship and vice versa. While the drawing of causal inferences is informed by scientific expertise, it is not a determination that is made using scientific methodology. (pg. 375)

NIOSH witness Dr. Larry Fine stated in his testimony:

Again, it's always hard to talk in generalizations, but in a situation where you have evidence of a biologically plausible explanation for the relationship between exposure and disease, where you had a body of cross-sectional studies that had accurate exposure assessment and accurate health outcomes; in that setting, we believe that you may well infer causality, particularly if you see, in studies with a wide range of exposure, a dose-response relationship (Tr. 2095).

Second, OSHA has considered the NAS review of the NIOSH criteria for study inclusion and weighting (Ex. 26–37). In the NAS review seven epidemiologists specializing in ergonomics were asked about the NIOSH assessment's selection and weighting of studies. Each provided individual comments (*Id.,* pgs. 152–174). In general they concurred with the NIOSH approach. Dr. Frederick Gerr, Associate Professor, Rollins School of Public Health, Emory University, thought that NIOSH had included all important epidemiological evidence in its review (*Id.,* pg. 159), an opinion shared by Dr. Laura Punnett, Professor, University of Massachusetts, Lowell (*Id.,* pg. 162), Dr. Alfred Franzblau, Associate Professor of Occupational Medicine, University of Michigan School of Public Health (*Id.,* pg. 155), and Dr. David Wegman, Professor, University of Massachusetts Lowell (*Id.,* pg. 172). With respect to the four criteria NIOSH chose to use to further qualitatively weight each study, some of the NAS participants found that these ''criteria for identifying studies of relatively greater methodological rigor are reasonable and appropriate'' (*Id.,* pg. 159), and ''that the studies most heavily relied on by NIOSH in its assessment of workplace factors and MSDs are of good quality.'' (*Id.,* pg. 156); and ''[t]he quality of the studies that were most heavily weighted was generally quite high because they met the multiple criteria set out by NIOSH for weighting. (*Id.,* pg. 172). One panelist, however, Dr. Howard Sandler (in a study co-authored with non-panelist Dr. Richard Blume), thought that this weighting method was neither fully explained nor tested and validated. (*Id.,* pg.168). Dr. Sandler was scheduled to appear at the OSHA hearing as an expert for Keller/Heckman but never did so.

Because of the NIOSH assessment's use of cross-sectional studies, the comments of Dr. Alfred Franzblau in discussing NIOSH's weighting of cross-sectional studies should be noted:

What some researchers have done is to perform cross-sectional studies among workers (and jobs) that are known to have been stable for some minimum period of time (*e.g.,* six months or one year). This type of cross-sectional design overcomes some of the shortcomings of cross-sectional studies relative to prospective studies, and serves to greatly strengthen the confidence one can have in the conclusion. Many of the studies that were most heavily weighted in the NIOSH assessment fall into this category (Ex. 26–37, pg. 156).

Dr. David Wegman provided the following summary comments:

There is no ''correct'' way to carry out a literature review particularly with as large a scope as the one undertaken by NIOSH. The authors of the NIOSH report are to be commended for developing a methodology that is reasonable, understandable, clearly presented, open and conservative. It is hard to imagine a more effective way to summarize this literature (Ex. 26–37, pg. 173).

Third, several witnesses and commenters on OSHA's ergonomics proposal also addressed the use of multiple types of epidemiological studies to determine causality. Dr. John Frank, Professor of Public Health Sciences, University of Toronto, stated in his testimony:

The best design cannot be read from a cookbook which automatically requires there to be a rank ordering of study design qualities for all circumstances. Prospective studies can actually make some mistakes that are overcome in well designed case-control studies (Tr. 1472).

Dr. Laura Punnett, Professor, University of Massachusetts Lowell, in support of the conclusions of the NIOSH report pointed out that:

Almost all of the studies considered in the review have been published in the peer-reviewed scientific literature, meaning that they had already been through the standard scientific quality control process prior to their publication and review by NIOSH. (Tr. 864).

In a statement that contradicts the view of several witnesses stating that medicine must rely on randomized clinical trials (RCT) for determining causality (*e.g.,* see Ex. 32–241–3–4, pg. 7–10), Dr. Niklas Krause, of the Public Health Institute, discussed the necessity of doing a careful evaluation of all the evidence:

So there are design problems in any study. And there is no gold standard, not even the randomized control trial is the gold standard as some people say. Epidemiologists say it. It is not the gold standard. You have to use all the available evidence. It is a careful evaluation of all the methodological features from measurement to control group to the timing and going through criteria that are important for causation as laid down by Hill and others. There is a discussion among us, you know, [about] which are the most important ones. But I think we all agree * * * we have established temporality in another way than doing a longitudinal study. And it can be established. We have repeated that. Then, all study designs are equally important. (Tr. 1476). * * * If you disregard all the cross-sectional studies for causal inference, you would not have medicine. (Tr. 1411).

When questioned about the cross-sectional design's inability to establish temporality, a key factor for determining causality, Dr. Krause further stated that in his studies this was not the case:

To give you an example, in our cross-sectional studies of the bus drivers, we measured the years of occupational driving. These years clearly occurred before they said to us I have back pain now. I have no doubt that these risk factors are [temporal], in a [temporal] relationship or coming before the back pain. And so this study qualifies for causal inference as a cross sectional study. I would not disregard this. (Tr. 1411).

The AFL–CIO post-hearing comments provide their analysis of the OSHA record with respect to the evidence for causality (Ex. 500–218). In discussing the types of studies that can be used to determine causality, they stated:

The record evidence clearly establishes that cross-sectional and case-control studies have been and can be used to identify causal relationships between exposures to risk factors and adverse health outcomes. In fact, the record demonstrates that cross-sectional and case-control studies have been used with great success to infer causal relationships addressing some of our nation's most important public health issues, such as smoking and lung disease, which have led to life-saving intervention measures in the absence of prospective studies. The record also does contain prospective epidemiological studies which have confirmed findings from cross-sectional and case-control studies that exposure to biomechanical/physical factors in the workplace cause MSDs among exposed workers.

(*Id.,* pg. 30)

In summary, with respect to the selection, use, and weighting of studies of multiple designs to make a determination of the causality between work-related stress factors and MSDs, OSHA concludes that the NIOSH approach is sound.

With respect to Dr. Fisher's comment that a formal methodology for combining study results to derive a weighted estimate of effect is a meta-analysis and that NIOSH did not perform a proper meta-analysis, OSHA agrees that NIOSH's analysis was not that of a formal meta-analysis. However, neither Dr. Fisher nor anyone else has provided a formal meta-analysis of the epidemiological literature to the record. Furthermore, OSHA notes that a necessary criteria for combining studies in a successful meta-analysis is that only studies measuring similar factors and estimating very similar effects should be analyzed together. OSHA's review of the database has determined that comparisons both between and within occupations with higher versus lower risk factors can be made in the various studies in a basic weight-of-evidence approach. However, a rigorous meta-analytic approach for a combined risk estimate is much more problematic because of the many factors being studied and the different response measures.

In addressing NIOSH's reliance on a qualitative evaluation of the epidemiology rather than a formal meta-analysis, Dr. David Wegman, Professor, University of Massachusetts Lowell, stated in his review for the NAS:

Meta-analysis is not appropriate when the question under study is as broad as the one NIOSH addressed. In my judgement [another writer] * * * provides the answer which, in his words is: ''I question whether quantitative methods can ever be as thoroughgoing, probing and informative as qualitative methods'' [Ex. 26–37].

The NAS Panel's Steering Committee concluded, with respect to the findings of the seven epidemiology experts on the NAS panel about combining studies for an overall risk estimate:

Methods used for the assessment of exposures and health outcomes vary [among studies], rendering the task of merging and combining evidence more challenging than in some other areas of risk assessment. But this variability does provide the benefit of multiple perspective on a common set of problems [Ex. 26–37].

In summary, OSHA finds no support for Dr. Fisher's comment that NIOSH erred by not performing a proper meta-analysis. Neither Dr. Fisher nor anyone else has provided any specific evidence to support his contention that a meta-analysis approach would be appropriate in this case. Instead, OSHA concurs with the National Academy of Science's conclusion that a formal meta-analysis would not be the best methodology in this case.

Gibson, Dunn & Crutcher also claimed that OSHA did not properly evaluate the epidemiological evidence according to the Reference Manual On Scientific Evidence (Ex. 500–197). Gibson, Dunn & Crutcher cited the following alleged weakness: that OSHA characterized the epidemiological evidence as proving cause while the *Manual* makes clear that epidemiological studies address association not causation, and that OSHA relied on studies of ''employee's recollection of the details of past job duties * * * and measures such as job titles coupled with the assumption that job duties were consistent across all job titles.'' (*Id.,* pg. I–55). The *Manual* criticizes studies that rely on the memory of subjects and states a preference for measurement of exposure. The *Manual* says that the outcome or health effect being studied must be clearly defined, yet OSHA relied on ''studies that examine subjective memories regarding an individual's experience with or personal tolerance for pain.'' (*Id.,* pg. I–56). While NIOSH found that many studies ''did not take into account [confounding] factors beyond job duties and produced odds or risk ratios that were not statistically significant'' (*Id.,* pg. I–57), OSHA ''just picked the ones that purport to show results favoring its hypothesis'' and ''routinely relied on studies reporting associations or odds ratios well below 9–10 and indeed often below 2.'' (*Id.,* pg. I–59). According to Gibson, Dunn & Crutcher, the Manual ''indicates that where risk ratios are significantly below nine or ten there is a probability that unmeasured factors are the true causes of the effect or disease being studied.'' (*Id.,* pg. I–58).

Gibson, Dunn & Crutcher mischaracterized the nature of the epidemiological studies on which OSHA relied, the criteria used by OSHA to evaluate those studies, and the conclusions OSHA drew from those studies. They also misconstrue a key section of the *Manual*. OSHA did not simply rely on epidemiological studies in which exposures were assumed but never measured and in which the health outcome was simply self-reported memories of pain. For each MSD, OSHA relied primarily on a subset of studies in which exposure to work-related biomechanical factors was directly observed or measured and for which the health outcome was clearly defined by a combination of symptoms and physical exam. This meets the *Manual's* preference for objective and uniform exposure measures and case definition. It is also compatible with the 1997 NIOSH analysis, which quite properly give the greatest weight to studies that involved objective exposure assessments and physical examinations in their evaluation of the evidence (Ex. 26–1, pg. 1–10).

For example, in the case of epicondylitis and other elbow MSDs, thirteen epidemiological studies based case definition on physical examination and worker exposure determined by observational analysis (see Table V–3). In these studies, the diagnosis of epicondylitis was consistent and required both pain on palpation of the epicondylar area and pain at the elbow with resisted movement of the wrist. Exposures relied on videotaped analysis of job tasks to group exposed and unexposed workers, sometimes with quantitative estimates of cycle times (for repetition), static loading on the forearm (for force), and wrist posture. Nine of the thirteen studies found statistically significant associations between epicondylitis and exposure to work-related physical factors (see, *e.g.,* Exs. 26–907; 500–41–131; 26–53; 26–1117; 26–1364; 26–1433; 500–41–116; 26–945; 26–1473). Six of the studies reported odds ratios or other risk measures of five or greater (Exs. 26–907; 500–41–111; 26–43; 26–1117; 26–1364; 26–1433). One study found that the rate of repetitive exertions is highly predictive (p=0.002) of epicondylitis (Ex. 500–41–116). Two studies reported odds ratios greater than ten (Exs. 26–907; 500–41–111). This is a much different pattern of risk ratios than that presented by Gibson, Dunn & Crutcher, which claims that odds ratios are well below 9–10 and often around 2.

The *Manual* does not state risk ratios below 10 may indicate that confounding factors are responsible for the association, as implied by Gibson, Dunn & Crutcher. The *Manual* states ''a relative risk of 10 * * * is so high that it is extremely difficult to imagine any bias or confounding factor that might account for it.'' (pg. 376). The *Manual* goes on to say that ''although lower relative risks *can* (emphasis added) reflect causality, the epidemiologist will scrutinize such associations more closely because there is a greater chance that they are the result of uncontrolled confounding or bias.'' (Pg 377).

The *Manual* also discusses the Hill criteria previously cited. OSHA has evaluated the epidemiological evidence against these criteria. As mentioned above, the large number of studies reporting significant associations and risk ratios above five speaks to the strength of the association and the replicatibility of the findings for MSDs of the elbow. As further explained in the Health Effects section, there was one prospective cohort study of meat cutters that provided evidence of a temporal relationship between repetitive, forceful exertions of the forearm/elbow and epicondylitis (Ex. 26–53). In addition, several cross-sectional studies indicated an exposure-response relationship between the intensity or duration of repetitive exertions and the prevalence of MSDs (Exs. 500–41–116; 500–41–111; 26–1117; 26–697; 26–1473). Two studies reported ORs between 1 and 3 that were not statistically significant, probably because the workers were exposed to relatively low force directed at the forearm (Exs. 26–56; 26–697). Another study that did not find an association may have misclassified exposure, according to NIOSH (Ex. 26–1211). As a group, OSHA found that the studies relied on generally controlled for important confounders and bias, although not every individual study did so. Pathology information that epicondylitis is caused by microrupture of the tendons resulting from overuse of the forearm muscles, and the well-established connection between epicondylitis and racquet sports (*i.e.,* tennis elbow) establish the biological plausibility of the relationship.

The evidence briefly described above led OSHA to conclude that workers that perform job tasks requiring repeated forceful movements, especially flexion, pronation, or supination with the arm extended, are at increased risk of substantial and serious musculoskeletal impairment to the elbow. In its analysis of the epidemiological literature, NIOSH also concluded there was strong evidence for a relationship between exposure to a combination of work-related physical factors and epicondylitis (Ex. 26–1, pg 4–1 to 4–48). It should be noted that these OSHA and NIOSH conclusions do not, in fact, speak of causation as purported by Gibson, Dunn & Crutcher; both OSHA's and NIOSH's conclusions are careful to conform to the language of the *Manual*.

In Section V on health effects, OSHA evaluates the epidemiological evidence for MSDs of the upper extremity, shoulder, neck, back, and lower extremity, be focusing primarily on the most reliable studies. This usually means studies where exposures to physical work factors are directly observed or measured, not assumed based on job title, and the MSDs have been confirmed by a combination of symptoms, physical exam, and medical tests as appropriate. In addition to the evidence for epicondylitis cited above:

- Thirteen studies examined neck and neck/shoulder MSDs using physical exam and direct observation of exposure. All but one found significant associations between biomechanical risk factors and health outcome. At least three studies reported odds ratios greater than five (see Table V–1).
- Seventeen studies examined shoulder MSDs (mostly tendinitis) using physical exam and direct observation of exposure. All but one found significant associations between biomechanical risk factors and health outcome. At least six studies reported odds ratios greater than five (see Table V–2).
- Seven studies examined hand/wrist tendinitis using physical exam and direct observation of exposure. All but one found significant associations between biomechanical risk factors and health outcome. At least four studies reported odds ratios greater than five (Table V–4).
- Seventeen studies examined carpal tunnel syndrome using physical exam

and/or nerve conduction and direct observation of exposure. Thirteen found significant associations between biomechanical risk factors and health outcome. At least five studies reported odds ratios greater than five.

- Six studies examined hand/arm vibration syndrome using physical exam and vibration measurements. Four found significant associations between vibration and health outcome; all of which reported odds ratios greater than five.

OSHA has carefully evaluated the collective data base of studies for each MSD category using the criteria for causality cited in the *Manual* (pg. 374–378). OSHA used the epidemiological data, biomechanical research studies, and information addressing biological plausibility to draw its overall conclusions with regard to the evidence that the work-related biomechanical factors were responsible for the observed increase in the risk of health impairment. OSHA finds this evidence compelling and points to the need to take action to provide workers with necessary protection. OSHA does not believe that it is appropriate to wait for ''proof of causation'' since scientific evidence cannot ever establish causation beyond any doubt. As Sir Bradford Hill wrote over 35 years ago:

> All scientific work is incomplete—whether it is observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have or to postpone the action that it appears to demand at a give time (Ex. 26–726).

3. Evidence for Exposure Response Relationships

Several submissions, such as those submitted by the U.S. Chamber of Commerce and experts testifying on behalf of United Parcel Service (Exs. 30–1722, 32–241–3–19, 32–241–3–13, 30–4184, 30–1552), claimed that there is no epidemiologic evidence of exposure-response (or ''dose-response'') relationships between MSDs and the physical ergonomic stressors addressed by the OSHA standard. In their joint written testimony on the proposed rule, Kellie Truppa and Dr. Michael Vender, for example, stated:

> While it may seem very intuitive that decreasing reported ergonomic stressors would decrease disorders, there is no scientific study that has demonstrated a decrease in the incidence of true disease directly attributable to actual ergonomic changes. Unlike other risk factors to health (*e.g.*—smoking) there is no concept of threshold exposure or dose-response in relating ergonomic risk exposure to the development of disease. Therefore, there can be no predictability or guarantee of any benefit with reduction of ergonomic exposures * * * (Ex. 32–241–3–19).

In the preamble to the proposed rule, OSHA presented results of several studies that evaluated exposure-response trends; since publication of the proposal, OSHA has identified many more studies that provide evidence that, as the level (intensity, frequency or duration) of exposure increases, so does the risk of MSDs. OSHA summarizes this evidence in this section of the preamble. Based on these studies, OSHA finds that there is substantial evidence for a positive relationship between duration and intensity of exposure to biomechanical risk factors and the risk of developing MSDs, and that this evidence strengthens the causal relationship between exposure and risk.

One of the key criteria for demonstrating a causal relationship is evidence that the prevalence or incidence of a health outcome increases with an increase in the level of exposure to a hazardous condition. In occupational epidemiological studies, an exposure-response relationship is demonstrated when there is a statistical association between the prevalence or incidence of the health outcome in at least three groups of workers each with a varying degree of exposure (*e.g.,* no exposure, low exposure, high exposure). When exposure response relationships are based on groups of workers, the exposure variable is represented as an ordinal variable. Alternatively, statistical analysis can be performed on data for individual members of study cohorts to derive statistical functions that reflect the exposure-response relationship; in this case, the exposure variable is represented as a continuous variable. For this section, studies were included if the risk between musculoskeletal disorders and exposure to one or more biomechanical risk factors were examined using either of these two approaches. In the studies compiled here, the most common presentations of exposure response relationships are when the prevalence, incidence, odds ratio, or risk ratio for an MSD increases from one exposure category to the next. Typically these are accompanied by confidence intervals or a test of linear trend, as measures of statistical stability. In other studies, the exposure-response relationship may be expressed in the form of a statistically significant linear regression coefficient, or (partial) correlation coefficient, showing that, as exposure increases so does the prevalence or risk.

An exposure-response relationship, when present, is considered to strengthen the evidence of a causal relationship because it is believed to be a characteristic of cause-effect situations, in general, absent evidence to the contrary. In addition, it is thought that it would be more difficult for many or most forms of bias or confounding to produce an artifactual exposure-response relationship than to bias a simple association such as an odds ratio. However, it is not a sine qua non, in that an epidemiologic study can provide valuable information even if both exposure and outcome are represented only as dichotomous variables (*i.e.,* exposed versus unexposed), nor does it make unnecessary consideration of methodologic issues that must be addressed when evaluating a given study. Furthermore, the lack of an exposure-response relationship is not necessarily evidence against a causal effect.

The studies cited in this section utilized a wide range of exposure measures, including worker self-reports, observation, and direct measurement. As several authors have noted, even though exposure units and scaling vary, there is an overall consistency between self-reports and other, presumably more objective, measures in these studies (*e.g.,* Booth-Jones et al., 1998: Ex. 500–121–9; Jensen et al., 2000: Ex. 500–41–68; Neumann et al., 1999: Ex. 38–85; Pope et al., 1998: Ex. 500–71–67). This suggests that worker perception provides a useful guide to the identification of jobs involving high exposures to physical risk factors, and that, in general, the jobs that will be identified as potentially hazardous by workers' own evaluations will generally correspond to those that would be identified as potentially hazardous by other measures. The results of studies that have examined exposure-response relationships are summarized in Tables V–9 through V–13, and are summarized briefly below.

Work Pace and Repetition

There is substantial evidence of an exposure-response relationship for MSDs of the neck and shoulders. For example, in a case-control study of the general population in Sweden, the odds of neck/shoulder disorders increased markedly with work pace levels from slow to medium to rushed, as well as with hours per day of performing repetitive precision movements at work (Ekberg et al., 1994: Ex. 26–1238). Ohlsson *et al.*found positive associations with both the number of items handled per hour in repetitive assembly work and the number of years employed in such work, especially among younger employees (Ohlsson et al., 1989: Ex. 26–1290). Johansson *et al.* studied blue- and white-collar manufacturing employees separately and reported exposure-response relationships with monotonous movements at work in each group (Johansson et al., 1994: Ex. 26–1331).

TABLE V–9.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS WITH EXPOSURE TO REPETITIVE MANUAL WORK

Measure of repetitiveness (unit)	Health outcome/body region affected	Measure of effect	Reference
Neck and Shoulder			
Years sewing machine operator (4 categories).	Neck/Shoulder	Odds Ratio [unadj] 0 (control: 1.0 0–7: 2.3 (0.5–11.0) 8–15: 6.8 (1.6–28.5) >15: 16.7 (4.1–67.5)	Andersen *et al.*(1993: Ex. 26–1451).
Years sewing machine operator (4 categories).	Chronic neck pain	Odds Ratio [adj] 0 (control): 1.0 0–7: 1.9 (1.3–2.9) 8–15: 3.8 (2.3–6.4) >15: 5.0 (2.9–8.7)	Andersen *et al.*(1993: Ex. 26–1502).
Years sewing machine operator (4 categories).	Chronic should pain	Odds Ratio [adj] 0 (control): 1.0 0–7: 1.4 (0.9–2.4) 8–15: 3.9 (2.3–6.5) >15: 10.3 (5.9–17.9)	Andersen *et al.*(1993: Ex. 26–1502).
Years sewing machine operator (4 categories).	Chronic neck and/or shoulder pain.	Odds Ratio [adj] 0 (control): 1.0 0–7: 1.8 (1.2–2.6) 8–15: 4.3 (2.6–6.9) >15: 8.0 (4.7–13.8)	Andersen *et al.*(1993: Ex. 26–1502).
Data entry at video display unit (hours/week).	Neck (cervical diagnoses)	Odds Ratio [adj] 5–20 hr/wk: 1.2 (0.4–4.3) ≥20 hr/wk: 1.7 (0.7–4.3)	Bergqvist *et al.*(1995: Ex. 26–1195, 500–165–25).
Data entry at video display unit	Neck/shoulder	Odds Ratio [adj] Data entry: 1.4 (0.7–2.9) Data entry plus limited rest breaks: 4.8 (1.3–18.1)	Bergqvist *et al.*(1995: Ex. 26–1195, 500–165–25).
Typing speed	Neck	Prevalence [unadj] (test of trend): Slow: 10% Moderate: 14% Fast: 25% (p<0.001)	Burt *et al.*(1990: Ex. 26–698).
Percentage of time typing	Neck	Odds Ratio [adj] <20: 1.0 20–39: 2.0 (1.0–7.7) 40–59: 2.6 (1.4–5.0) 60–79: 2.2 (1.0–4.7) 80–100: 2.8 (1.4–5.4)	Burt *et al.*(1990: Ex. 26–698).
Typing speed	Shoulder	Odds Ratio [adj] Slow: 1.0 Moderate: 2.6(1.1–5.9) Fast: 4.1 (1.8–9.4))	Burt *et al.*(1990: Ex. 26–698).
Percentage of time typing	Shoulder	Prevalence [unadj] (test of trend): 0–19: 6% 20–39: 10% 40–59: 13% 60–79: 11% 80–100: 15% (p=.10)	Burt *et al.*(1990: Ex. 26–698).
Repetitive precision movements (hours/day) (3 categories).	Neck/Shoulder	Odds Ratio [adj] Low: 1.0 Medium: 3.8 (0.7–20) High: 15.6 (2.2–113)	Ekberg *et al.*(1994: Ex. 26–1238).
Work pace (3 categories)	Neck/Shoulder	Odds Ratio [adj] Low: 1.0 Medium: 7.6 (1.6–36) Rushed: 10.7 (2.2–52)	Ekberg *et al.*(1994: Ex. 26–1238)
Hour per day of video display terminal (VDT) use.	Neck, shoulder, upper back (“upper torso”).	Odds Ratio [unadj] per hour 1.4 (1.0–2.0)	Faucett *et al.*(1994: Ex. 38–256)
Monotonous working movements (duration of repetitive movements, static stress and sitting).	Neck (in white collar workers)	Partial correlation coefficient [adj] 0.38 (p < 0.05)	Johansson *et al.*(1994: Ex. 26–1331)
Monotonous working movements (duration of repetitive movements, static stress and sitting).	Shoulder (in white collar workers)	Partial correlation coefficient [adj] 0.32 (p < 0.05)	Johansson *et al.*(1994: Ex. 26–1331)

TABLE V–9.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS WITH EXPOSURE TO REPETITIVE MANUAL WORK—Continued

Measure of repetitiveness (unit)	Health outcome/body region affected	Measure of effect	Reference
Monotonous working movements (duration of precision movements, repetitive movements, and static and stress).	Shoulder (in blue collar workers)	Partial correlation coefficient [adj] 0.15 ($p < 0.05$)	Johansson *et al.*(1994: Ex. 26–1331)
Years employed in repetitive assembly work.	Neck	Increasing odds (graphical presentation only)	Ohlsson *et al.*(1989: Ex. 25–1290)
	Shoulder	Increasing odds (p=0.03); below 35 years of age, p=0.01	
Work pace (items/hour) (4 categories).	Shoulder	Odds Ratio [adj] < 100: 1.0 100–199: est 8.0 (p=0.0006) 200–700: est 9.0 (p=0.0006) > 700: est 2.0 (p-value not given)	Ohlsson et al. (1989: Ex. 26–1290)
Hours per day of VDT use (4 categories).	Neck	Prevalence [unadj] (test of trend): 0 hr: 7% 0.5–3 hr: 7% 4–6 hr: 12% ≥7 hr: 19% (p<0.00001) Odds Ratio [adj] 0 hr: 1.0 0.5–3 hr: 1.8 (0.5–6.8) 4–6 hr: 4.0 (1.1–14.8) ≥7 hr: 4.6 (1.7–13.2)	Rossignol *et al.*(1987: Ex. 26–804)
Hours per day of VDT use (4 categories).	Shoulder	Prevalence [unadj] (test of trend): 0 hr: 6% 0.5–3 hr: 5% 4–6 hr: 10% ≥7 hr: 16% (p=< 0.00001) Odds Ratio [adj] 0 hr: 1.0 0.5–3 hr: 2.5 (0.7–10.8) 4–6 hr: 4.0 (1.0–16.9) ≥7 hr: 4.8 (1.6–17.2)	Rossignol *et al.*(1987: Ex. 26–804)
Sewing machine operation (years of employment).	Neck	Odds Ratio [unadj] < 8 yrs: 1.0 8–14 yrs: 1.1 (0.4–2.6) ≥15 yrs: 2.1 (0.8–5.6	Schibye *et al.*(1995: Ex. 26–1463)
	Shoulder	< 8 yrs: 1.0 8–14 yrs: 1.3 (0.5–3.4) ≥	15 yrs: 4.3 (1.5–12.5)
Arm and Elbow			
Data entry at video display unit (hours/week).	Arm/hand	Odds Ratio [unadj] 5–20 hr/wk: 1.6 (0.6–4.5) ≥ 20 hr/wk: 1.8 (0.8–3.9)	Bergqvist *et al.*(1995: Exs. 26–1195, 500–165–25)
Percentage of time typing	Elbow/forearm	Odds Ratio [adj] 20–39%: 1.2 (0.6–22.5) 40–59%: 1.7 (0.8–3.5) 60–79%: 1.9 (0.9–4.3) 80–100%: 2.8 (1.4–5.7)	Burt *et al.*(1990: Ex. 26–698)
Typing speed	Elbow/forearm	Prevalence [unadj] (test of trend): Slow: 7% Moderate: 11% Fast: 13% (p=0.02)	Burt *et al.*(1990: Ex. 26–698)
Hours per day of VDT use	Arm	Prevelance [unadj] (test of trend): 0 hr: 4% 0.5–3 hr: 2% 4–6 hr: 4% ≥7 hr: 7% (p=0.01)	Rossignol *et al.*(1987: Ex. 26–804)

TABLE V–9.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS WITH EXPOSURE TO REPETITIVE MANUAL WORK—Continued

Measure of repetitiveness (unit)	Health outcome/body region affected	Measure of effect	Reference
Hand and Wrist			
Typing at video display unit (hours/day).	Hand/wrist	Odds Ratio [adj] 0–<2 hr: 1.0 2–<4 hr: 1.3 (0.6–1.8) 4–<6 hr: 1.3 (0.8–2.2) 6–≥8 hr: 2.1 (1.3–3.6) ≧8 hr: 3.3 (1.2–8.9)	Bernard *et al.*(1994: Ex. 500–165–21)
Typing speed	Hand/wrist	Odds Ratio [adj] Slow: 0.9 (0.3–2.3) Moderate: 1.3 (0.6–3.1) Fast: 2.5 (1.0–5.6)	Burt *et al.*(1990: Ex. 26–698)
Percentage of time typing	Hand/wrist	Prevalence [unadj] (test of trend): 0–19: 13% 20–39: 23% 40–59: 27% 60–79: 30% 80–100: 24% (p<0.01)	Burt *et al.*(1990: Ex. 26–698)
Hours per day of video display terminal (VDT) use.	Hand and arm	Odds Ratio [unadj] per hour 1.5 (1.1–2.0)	Faucett *et al.*(1994: Ex. 38–256)
Repetition rating (1 unit on 0–10 scale).		Odds Ratio [adj]:	Latko *et al.*(1999: Ex. 38–171)
	Dominant wrist/hand/fingers Tendinitis (distal upper extremity) Carpal tunnel syndrome	1.17 (1.06–1.29) 1.23 (1.04–1.46) 1.16 (1.00–1.34)	
Cycle length (seconds), in work performed 4–8 hours per day.	Carpal tunnel syndrome	Odds Ratio [adj] ≥1 min: 1.0 30–59 s: 1.03 (0.56–1.89) 10–29 s: 1.33 (0.75–2.37) <10 s: 1.90 (1.04–3.48)	Leclerc *et al.*(1998: Ex. 500–205–11)
Years employed in repetitive assembly work.	Hand	Increasing odds (p=0.002)	Ohlsson *et al.*(1989:Ex. 26–1290)
Repetitive wrist motions (years of exposure).	Carpal tunnel syndrome	Odds Ratio [unadj] <1 yr: 1.0 1–20 yrs: 2.3 (0.7–7.9) >20 yrs: 9.6 (2.8–33.0)	Wieslander et al.(1989: Ex. 26–1027)
Multiple Body Regions			
Piece-rate wage system (years of employment).	Musculo- skeletal diseases	Odds Ratio [adj] 0–4 yrs: 1.0 5–9 yrs: 4.3 (0.5–35.9) 10–14 yrs: 10.0(1.0–79.3) 15–19 yrs. 8.0 (0.8–76.8) ≥20 yrs: 11.4 (0.9–137.1)	Brisson *et al.*(1989: Ex. 26–937)
Hours per week of video display terminal use.	Upper extremity and back	Mean hours per week [unadj] 30 in cases, 27 in non-cases (p<0.05)	Knave *et al.*(1985: Ex. 26–753)
Percentage of recovery time per work cycle.	Upper extremity	Linear regression coefficient [unadj]: Ln(% recovery): 0.6 (r^2=0.49, p<0.001)	Moore *et al.*(1994: Ex. 26–1033)
Hours per day at keyboard	Hand, wrist, forearm and/or elbow	Prevalence [unadj] (test of trend): 3 hr: 21% 4 hr: 24% 6 hr: 45% 6 hr: 50% >6 hr: 86%(p<0.00001)	Oxenburgh (1987: Ex. 26–1367)
Keyboarding speed	Upper extremity	Prevalence [unadj] (test of trend): <40 wpm: 17% 40–60 wp,: 22% >60 wpm: 29% (p=0.025)	Polanyi *et al.*(1997): Ex. 500–41–106)
Daily time keyboarding (hours per day).	Upper extremity	Means (test of difference) [unadj]: Cases 3.9 hours/day, controls 3.2 hours/day (p<0.001)	Polanyi *et al.*(1997: Ex. 500–41–106)

Note: adj = adjusted for other covariate(s)
unadj = not adjusted for other covariates

TABLE V–10.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS WITH EXPOSURE TO FORCEFUL MANUAL EXERTION

Measure of manual force (unit)	Health outcome/body region affected	Measure of effect	Reference
Neck and Shoulder			
Grocery checking: hours per week of checking work.	Shoulder	Odds Ration [unadj] <20: 1 20–25: 1 >25: 3.6 (p<0.05)	Baron *et al.*(1991: Ex. 26–697)
Forearm rotation while exerting very high forces (Frequency of exposure * Years of exposure).	Shoulder	Odds Ration [adj] per unit:	Hughes *et al.*(1997: Ex. 26–907)
	Interview Examination	92 (7.3–±) 46 (3.8–550)	
Light materials handling [factor formed from frequency and duration of materials handling 0.5–<1 kg and 1–5 kg].	Shoulder (in white collar workers)	Partial correlation coefficient [adj] 0.18 (p < 0.05)	Johansson *et al.*(1994: Ex. 26–1331)
Years of carpentry work (<10, 10 to <20, 20+ years).	Shoulder	Odds Ration [adj] 10–<20 yr: 2.3 (1.0–5.4) 20+ yr: 3.2 (1.1–8.9)	Lemasters *et al.*(1998: Ex. 500–121–44)
Load lifted (cumulative exposure, in 3 categories: 0–709; 710–25,999; and >25,999 kg).	Shoulder: acromio-clavicular osteoarthritis.	Odds Ratio [adj] (per category) Right side: 1.55 (1.03–2.34) Left side: 2.55 (1.50–4.35)	Stenlund *et al.*(1992: Ex. 26–733)
Load lifted (cumulative exposure, in 3 categories: 0–709; 710–25,999; and >25,999 kg).	Shoulder tendinitis	Odds Ratio [adj] (per category) Right side: 1.02 (0.59–1.76) Left side: 1.81 (0.95–3.44)	Stenlund *et al.*(1993: Ex. 502–462
Arm and Elbow			
Grocery checking: hours per week of checking work.	Elbow	Elbows Odds Ratio [unadj] <20: 1 20–25: 1.4 >25: 2.8 (p<0.05)	Baron *et al.*(1991: Ex. 26–697)
Forearm rotation while exerting very high forces (Frequency of exposure * Years of exposure).	Elbow/forearm: Interview Examination	Odds Ratio [adj] per unit: 4 (0.2–4) 37.0 (3.0–470)	Huges *et al.*(1997: Ex. 26–907)
Strenuous exertions (years of high exposure).	Epicondylitis	Odds Ratio [adj] 0 yr: 1.0 1–14 yr: 1.8(0.6–5.9) 15–38 yr: 3.3 (0.9–12.5)	Ritz (1995: Ex. 26–1473)
Hand and Wrist			
Hand forces (finger flexor muscles on electromyography).	Carpal tunnel syndrome	Average force (test of difference in means): Cases: 4.3 ″ 3.5 kp Noncases: 3.8 ″ 3.2 kp (p<0.05)	Armstrong *et al.*(1979: Ex. 500–41–8)
Grocery checking (years of exposure).	Hand/wrist	Odds Ratio [adj] 0–5: 1 5–10: 2 10+: 6 (p<0.05)	Baron *et al.*(1991: Ex. 26–697)
Grocery checking (years of exposure).	Carpal tunnel syndrome	Odds Ratio [adj] 0–5: 1 5–10: 4 10+: 15 (p<0.05)	Baron *et al.*(1991: Ex. 26–697)
Grocery checking (hours per week of exposure).	Carpal tunnel syndrome	Odds Ratio [adj] <20: 1 20–25: 2.3 >25: 4.8 (p<0.05)	Baron *et al.*(1991: Ex. 26–697)
Forearm rotation while exerting very high forces (Frequency of exposure * Years of exposure).	Hand/wrist: Interview Examination	Odds Ratio [adj] per unit 17.0 (2.9–106) 9.3 (1.0–90)	Hughes *et al.*(1997: Ex. 26–907)
Years of carpentry work (<10, 10 to <20, 20+ years).	Hand and wrist	Odds Ratio [adj] 10 – lt;20 yr: 2.4(1.1–5.3) 20+yr: 3.1(1.1–8.4)	Lemasters *et al.*(1998: Ex. 500–121–44)
Biomechanical index from direct measurements of force and posture.	Carpal tunnel syndrome	Linear regression [unadj] Flexion 0.017(r=0.62) Extension: 0.035(r=0.26)	Loslever *et al.*(1993: Ex. 26–161)

TABLE V–10.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS WITH EXPOSURE TO FORCEFUL MANUAL EXERTION—Continued

Measure of manual force (unit)	Health outcome/body region affected	Measure of effect	Reference
Mean relative finger flexor force (by EMG)/45–90 minute work sampling period.	Wrist	Linear regression coefficient [adj]: Mean relative deviation angle ($p<0.05$) Mean relative EMG signal ($p<0.05$) Seniority (years employed) ($p<0.05$)	Malchaire *et al.*(1996: Ex. 26–1473)
Manual force (as % MVC, in 5 categories).	Upper extremity	Linear regression [unadj]: Ln (Force: 2.0 ($r^2=0.49$, $p<0.001$)	Moore *et al.*(1994: Ex. 26–1033)
Forceful wrist motions (3 categories: low, medium, high).	Carpal tunnel syndrome By history.	Prevalence [unadj] (test of trend) Low: 0% Medium: 10% High: 63% (p=0.00006)	Osorio *et al.*(1994: Ex. 26–807)
	By nerve conduction velocity	Low: 0% Medium: 7% High: 33% (p=0.02)	
Forceful wrist motions (years exposed).	Carpal tunnel syndrome	Linear regression [adj], $p<0.05$ for: Right median nerve conduction velocity	Osorio *et al.*(1994: Ex. 26–807)
Grip >6 lb. per hand (3 categories of frequency).	Hand/wrist	Prevalence [unadj] (test of trend) None: 41% Some: 40% Frequent: 65% (p=0.30)	Stetson *et al.*(1993: Ex. 26–1221)
High load on wrist (years of exposure).	Carpal tunnel syndrome	Odds Ratio [unadj] <1 yr: 1.0 1–20 yr: 2.1 (0.8–5.2) >20 yr: 6.6 (1.4–14.7)	Wieslander *et al.*(1989: Ex. 26–1027)
Back			
Frequency of lifting per shift	Low back	Prevalence [unadj] 0/shift: 29% 1–5/shift: 33% 6–10/shift: 49% 11–20/shift: 55% >20/shift: 54%	Arad *et al.*(1986: Ex. 500–41–7)
Frequency of lifting >11.3 kg (times per day).	Prolapsed lumbar disc	Odds Ratio [adj] (test of trend): 0: 1.0 <5: 1.6 (0.4–6.1) 5–25: 2.7 (0.8–9.2) >25: 4.9 (0.5–47.6) (p=0.02)	Kelsey *et al.*(1984: Ex. 500–41–73)
Frequency of lifting >11.3 kg (times per day).	Prolapsed lumbar disc	Odds Ratio [adj] (test of trend): 0: 1.0 <5: 1.2 (0.7–2.0) 5–25: 1.3 (0.7–2.5) >25: 3.5 (1.5–8.5) (p=0.01)	Kelsey *et al.*(1984: Ex. 500–41–73)
Frequency of carrying 11.3 kg (times per day).	Prolapsed lumbar disc	Odds Ratio [adj] (test of trend): 0: 1.0 <5: 1.0 (0.6–1.9) 5–25: 2.1 (1.0–4.3) >25: 2.7 (1.2–5.8) (p=0.004)	Kelsey *et al.*(1984: Ex. 500–41–73)
Lifting 11.3 kg while twisting	Prolapsed lumbar disc	Odds Ratio [adj] (test of trend): Never or rare: 1.0 Moderate: 2.5 (0.9–6.8) Often: 3.1 (1.3–7.5) (p=0.002)	Kelsey *et al.*(1984: Ex. 500–41–73)
Load on spine (12 continuous biomechanical variables: peak and daily integraetd load).	Low back	Odds Ratio [adj] for inter-quartile spreads: Peak lumbar shear (N): 1.7 (1.0–2.9) Cumulative lumbar disc compression (N s/shift): 2.0 (1.2–3.6) Peak hand force (N): 1.9 (1.2–3.1)	Kerr *et al.*(2000: Ex. 500–41–74)
Index of stone load (weight*hours/day).	Low back	Odds Ratio [adj]: None: 1.0 Intermediate: 1.8 (0.3–9.3) High: 4.0 (0.8–19.8)	Latza *et al.*(2000: Ex. 500–19–6)

TABLE V–10.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS WITH EXPOSURE TO FORCEFUL MANUAL EXERTION—Continued

Measure of manual force (unit)	Health outcome/body region affected	Measure of effect	Reference
Lifting demands index (''Job Severity Index'').	Back	Injury incidence rate, disabling injury incidence, and severity rate increased with JSI (graphical presentations)	Liles *et al.*(1984: Exs. 26–33, 500–41–88)
Dynamic trunk motions (31 continuous biomechanical.	Low back	Odds Ratio [adj] for combined weighted means of 5 variables: 10.7 (4.9–23.6)	Marras *et al.*(1993: Ex. 500–41–94)
Load on spine (12 continuous biomechanical variables: peak and daily integrated load).	Low back	Higher load in cases vs controls, by each variable (all p-values <0.04). Odds ratios [adj] computed both for full observed ranges of exposure and more conservatively for inter-quartile spreads: Peak shear (N) 1.5 (1.0–2.4) Peak trunk velocity (deg/sec) 1.6 (1.1–2.5) Integrated moment (MN m s) 1.4 (1.0–2.0) Usual hand force (N) 1.7 (1.2–2.6)	Norman *et al.*(1998: Ex. 38–84)
Transfer a patient on canvas and poles (frequency/average working shift).	Low back	Odds Ratio [adj] 0: 1.0 1–4: 1.0 (0.8–1.3) ≥5: 1.3 (0.8–2.1)	Smedley *et al.*(1995: Ex. 500–41–40)
Manually transfer patient between bed and chair (frequency/shift).	Low back	Odds Ratio [adj] 0: 1.0 1–4: 1.4 (1.1–1.9) 5–9: 1.8 (1.3–2.5) ≥10: 1.5 (1.1–2.1)	Smedley *et al.*(1995: Ex. 500–41–40)
Manually move patient around on bed (frequency/shift).	Low back	Odds Ratio [adj] 0: 1.0 1–4: 1.2 (0.8–1.7) 5–9: 1.6 (1.1–2.3) ≥10: 1.7 (1.2–2.4)	Smedley *et al.*(1995: Ex. 500–41–40)
Manually transfer patient between bed and chair (frequency/shift).	Low back	Odds Ratio [adj] 0: 1.0 1–4: 1.3 (0.9–1.7) 5–9: 1.6 (1.1–2.3) ≥10: 1.6 (1.1–2.3)	Smedley *et al.*(1997: Ex. 500–205–25)
Transfer patient between bed and chair with hoist (frequency/shift).	Low back	Odds Ratio [adj] 0: 1.0 1–4: 1.5 (1.0–2.0) ≥5: 1.6 (0.8–3.0)	Smedley *et al.*(1997: Ex. 500–205–25)
Manually move patient around on bed (frequency/shift).	Low back	Odds Ratio [adj] 0: 1.0 1–4: 1.3 (0.8–1.9) 5–9: 1.5 (1.0–2.3) ≥10: 1.7 (1.1–2.5)	Smedley *et al.*(1997: Ex. 500–205–25)
Lift patient in or out of bath with hoist (frequency/shift).	Low back	Odds Ratio [adj] 0: 1.0 1–4: 1.4 (1.0–1.9) ≥5: 2.1 (1.2–3.6)	Smedley *et al.*(1997: Ex. 500–205–25)
Frequent vs. infrequent lifting in patient care.	Back	Length of time at work without back injury longer for those with infrequent lifting demands (p<0.01 in survival analysis)	Stobbe *et al.*(1988: Ex. 500–41–45)
Lifting frequency (4 categories of hospital service area, from 1, lifting most, to IV, lifting least).	Back	Odds Ratio [adj] Area IV: 1.0 Area III: 1.26 (p>0.05) Area II: 1.73 (p>0.05) Area I: 4.26 (p<0.01)	Venning *et al.*(1987: Ex. 500–41–49)

TABLE V–10.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS WITH EXPOSURE TO FORCEFUL MANUAL EXERTION—Continued

Measure of manual force (unit)	Health outcome/body region affected	Measure of effect	Reference
NIOSH Lifting Equation Lifting Index (LI) (4 categories).	Low back (severity rating, range 0–5).	Mean severity (standard deviation): LI:<1: 0.18 (0.15) 1≤LI ≤3: 3.57 (0.86) LI>3: 4.07 (0.73) RWL*=0: 3.86 (0.75) ANOVA (α=0.05) *Recommended Weight Limit	Wang *et al.*1998 (1998: Ex. 500–41–52)
NIOSH Lifting Equation Lifting Index (LI).	Low back	Odds Ratio [unadj] 0: 1.0 0<LI ≤1: 1.1 (0.2–5.3) 1<LI ≤2: 1.5 (0.6–3.8) 2<LI ≤3: 2.5 (1.3–4.9) LI ≥3: 1.6 (0.7–4.0)	Waters *et al.*(1999: Ex. 500–121–76)
Strenuous physical activity at work (hours per day).	Back	Odds Ratio [unadj] 0–<2 hr: 1.0 2–<4 hr: 4.2 4–<6 hr: 6.4 6–<8 hr: 5.6 ≥8 hr: 6.8 Odds Ratio [adj] per hour of strenuous work: 1.14 (1.11–1.17)	Wild (Ex. 26–1104; 26–1107)
Physically hard work	Low back	Odds Ratio [unadj] (test of trend): No or seldom: 1.0 ¼ of the time: 1.3 ½ of the time 2.3 ¾ of the time: 2.2 All of the time: 2.5 (p<0.001)	Xu *et al.*(1997: Ex. 500–71–53)
Lower Extremity or Multiple Body Regions			
Strength demand of job (3 categories: none, some, much).	Knee (radiographic osteoarthritis)	Odds Ratio [adj] Men, ages 55–64: 1.9 (0.9–4.0) Women, ages 55–64: 3.1 (1.0–9.4)	Anderson *et al.*(1988: Ex. 26–926)
Kneeling, squatting or stair-climbing, with and without heavy lifting.	Knee osteoarthritis	Odds Ratio [adj] Neither kneeling nor lifting: 1.0 Kneeling/squatting: 2.5 (1.1–5.5) Kneeling and lifting: 5.4 (1.4–21.0)	Cooper *et al.*(1994: Ex. 500–41–27)
Maximum compressive force (lb.) on L5/S1 lumbar disc.	''Overexertion incidents'' by clinic visit.	Incidence rate (per 200,000 hours): <1000 lb: 65 1000–1500 lb: 150 >1500 lb: 208	Herrin *et al.*(1986: Ex. 26–961)
Index of physically strenuous load	Overall MSD morbidity: Symptoms Findings	Linear regression coefficient [adj]: 0.127 (p=0.002) 0.091 (p=0.026)	Leino *et al.*(1995: Ex. 32–241–3–54)
Years of carpentry work (<10, 10 to <20, 20+ years).	Knee	Odds Ratio [adj] 10–<20 yr: 1.9 (0.9–4.1) ≥20 yr: 3.5 (1.3–9.2)	Lemasters *et al.*(1998: Ex. 500–121–44)
Lifting at work (kilograms per day)	Knee Men: Women:	Odds Ratio [adj] Medium: 2.5 (1.5–4.4) High: 3.0 (1.6–5.5) Medium: 1.2 (0.7–1.9) High: 1.7 (1.0–2.9)	Sandmark *et al.*(2000: Ex. 500–41–114)

TABLE V–11.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS OF THE NECK AND SHOULDERS WITH EXPOSURE TO NON-NEUTRAL POSTURE

Measure of posture	Health outcome/body region affected	Measure of effect	Reference
	Neck and Shoulder		
Height of video display unit keyboard relative to elbow height (centimeters).	Neck/shoulder	Linear regression coefficient [unadj] 0.18 (−0.03, 0.40)	Bergqvist *et al.*(1995: Ex. 500–165–24)
Duration of shoulder flexion or abduction >60 degrees (hours/day).	Shoulder/neck	Ratio for cases vs. controls: Right: 2.0 (p <0.005) Left: 2.4 (p <0.025)	Bjelle *et al.*(1981: Ex. 26–1519)
Frequency of shoulder flexion or abduction >60 degrees (times/day).	Shoulder/neck	Ratio for cases vs. controls: Right: 2.0 (p <0.001) Left: 2.2 (p <0.005)	Bjelle *et al.*(1981: Ex. 26–1519)
Arms lifted (hours per day, 3 categories).	Neck/shoulder	Odds Ratio [adj] Low: 1.0 Medium: 2.4 (0.8–7.1) High: 4.8 (1.3–18)	Ekberg *et al.*(1994: Ex. 26–1238)
Elbow flexed >1 time/minute (per hour/day).	Shoulder	Odds Ratio [adj] 1.10 (0.98–1.23)	English *et al.*(1995: Ex. 26–848)
Head rotation	Neck, shoulder, upper back (“upper torso”).	R-squared [adj] Pain: 0.11 (p<0.01) Stiffness: 0.18 (p<0.01)	Faucett *et al.*(1994: Ex. 38–256)
Keyboard height relative to elbow	Neck, shoulder, upper back (“upper torso”).	R-squared [adj] Pain: 0.05 (p<0.05) Stiffness: 0.06 (p<0.05)	Faucett *et al.*(1994: Ex. 38–256)
Years of exposure to repetitive shoulder flexion (angle ≥30 degrees, 600 times/hour) with high forces.	Shoulder impingement syndrome	Increasing prevalence ratio [adj] with cumulative exposure nonlinear trend, p=0.002 for quadratic term	Frost *et al.*(1999: Ex. 38–97)
Hands above shoulder level (hours per day).	Neck/shoulder pain with impairment.	Prevalence Ratio [adj] <1 Hr. 1.1 (0.8–1.5) 1–4 hr. 1.5 (1.2–1.9) >4 hr. 2.0 (1.4–2.7)	Holmstrom et al (1992: Ex. 500–41–64)
Stooping (hours per day)	Neck/shoulder pain with impairment.	Prevalence Ratio [adj] <1 Hr. 1.0 (0.8–1.3) 1–4 hr. 1.4 (1.1–1.8) >4 hr. 1.5 (1.1–2.1)	Holmstrom et al (1992: Ex. 500–41–64)
Bent work postures [factor=duration of precision movements and head bent foward; frequency and duration of trunk forward flexion (20°–60°)].	Neck (in white collar workers)	Partial correlation coefficient [adj] 0.20 (p<0.05)	Johansson *et al.*(1994: Ex. 26–1331)
Twisted work postures [factor=duration of trunk rotation (>45°) and head rotation (>45°)].	Neck (in white collar workers)	Partial correlation coefficient [adj] 0.23 (p<0.05)	Johansson *et al.*(1994: Ex. 26–1331)
Extreme work postures [factor=frequency and duration of trunk forward flexion (>60°); frequency of trunk forward flexion (20°–60°); and duration of head rotation (>45°), trunk rotation (>45°), and work with hands above shoulders].	Shoulder (in blue collar workers)	Partial correlation coefficient [adj] 0.14 (p<0.05)	Johansson *et al.*(1994: Ex. 26–1331)
Twisted work postures [factor=duration of trunk rotation (>45°) and head rotation (>45°)].	Shoulder (in white collar workers)	Partial correlation coefficient [adj] 0.16 (p<0.05)	Johansson *et al.*(1994: Ex. 26–1331)
Percentage of work cycle with shoulder elevated.	Cervicobrachial (neck to hand)	Odds Ratio [adj] 1.04 (p<0.05)	Jonsson *et al.*(1988: Ex. 26–969)
Neck flexion (percentage of work cycle).	Neck	Regression coefficient p-value [adj] p<0.01	Kilbom *et al.*(1986: Ex. 500–41–75)
Shoulder elevated (percentage of work cycle).		Regression coefficient p-value [adj]	Kilbom *et al.*(1986: Ex. 500–41–75)
	Neck	p<0.05	
	Shoulder	p<0.05	
Neck flexion (movements per hour)	Neck/shoulder	Ratio of median for cases vs. controls [unadj] Total movements: 1.3 (p=0.008) Flexions ≥30°: 1.3 (p=0.02)	Ohlsson *et al.*(1995: Ex. 26–868)

TABLE V–11.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS OF THE NECK AND SHOULDERS WITH EXPOSURE TO NON-NEUTRAL POSTURE—Continued

Measure of posture	Health outcome/body region affected	Measure of effect	Reference
Frequency of shoulder flexion or abduction.	Neck/shoulder	Median elevation >30° (% of time) [unadj]: Cases=16, controls=9 (p=0.05) Median elevation >30° (movements per hour) [unadj]: Cases=60, controls=9 (p=0.004) Median abduction ≥60° (% of time) [unadj]: Cases=1, controls=0 (p=0.04) Median elevation ≥60° (movements per hour) [unadj]: Cases=47, controls=0 (p=0.04)	Ohlsson *et al.*(1995: Ex. 26–868)
Shoulder flexion or abduction >90 degrees (duration, as percentage of work cycle).	Left shoulder Right shoulder Either shoulder	Odds Ratio [unadj] (test of trend) >0%–<10%: 2.5 ≥10%: 5.1 (p=0.0001) >0%–<10%: 1.7 ≥10%: 2.8 (p=0.002) Ratio of mean duration in cases vs. controls [unadj]: 2.6 (p=0.003) Odds Ratio (95% CI) per 10% increment [adj]: 1.4 (1.1–1.8)	Punnett *et al.*(2000: Ex. 500–41–109
Twisted or bent postures (4 categories).	Neck/shoulder	Odds Ratio [adj] Little: 1.0 Moderate: 1.2 (1.0–1.5) Rather much: 1.6 (1.4–1.9) Very much: 1.8 (1.5–2.2)	Tola *et al.*(1988: Ex 26–1018)
Twisting of trunk (hours/day) (4 categories).	Neck	Odds Ratio [adj]: Not at all: 1.0 Little: 1.3 (0.7–2.4) Moderately: 1.9 (1.1–3.5) Much: 2.3 (1.2–4.3)	Viikari-Juntura *et al.*(2000: Ex. 500–41–50)
Working with hand above shoulder level (hours/day) (3 categories).	Neck	Odds Ratio [adj]: <0.5 1.0 0.5–1: 1.2 (1.0–1.3) >1: 1.4 (1.3–1.6)	Viikari-Juntura *et al.*(2000: Ex. 500–41–50)
Twisting or bending of trunk at work (3 categories).	Neck	Odds Ratio [unadj]: Very or rather little: 1.0 Moderate: 1.7 (0.9–9–3.2) Rather or very much: 1.9 (1.2–3.2)	Viikari-Juntura *et al.*(1994: Ex. 26–873)
		Hand and Wrist	
Wrist bending or twisting (per 2 hours/day).	Carpal tunnel syndrome	Odds Ratio [unadj] 1.5 (1.2–1.7)	Blanc at al. (1996); Ex. 26–42 500–41–16)
Wrist flexion (hours/week) (hours truncated at 40).	Carpal tunnel syndrome	Odds Ratio [unadj] 0: 1.0 1–7: 1.5 (1.3–1.9) 8–19: 3.0 (1.8–4.9) 20–40: 8.7 (3.1–24.1)	De Krom *et al.*(1990: Ex. 26–102)
Wrist extension (hours/week) (hours truncated at 40).	Carpal tunnel syndrome	Odds Ratio [unadj] 0: 1.0 1–7: 1.4 (1.0–1.9) 8–19: 2.3 (1.0–5.2) 20–40: 5.4 (1.1–27.4)	De Krom *et al.*(1990: Ex. 26–102)
Shoulder rotation with arm elevated, >1 time/minute (per hour/day).		Odds Ratio [adj]	English *et al.*(1995: Ex. 26–848)
	Wrist/forearm Carpal tunnel syndrome	1.6 (1.2–2.3) 1.8 (1.2–2.8)	
Shoulder rotation with elbow flexed, >1 time/minute (per hour/day).	Finger	Odds Ratio [adj] 5.1 (2.0–12.8)	English *et al.*(1995: Ex. 26–848)
Wrist flexion or extension (per 20 repetitions/min).	Thumb	Odds Ratio [adj] 1.4 (1.1–1.8)	English *et al.*(1995: Ex. 26–848)
Ulnar abduction (degrees of ''typical'' work posture).	Forearm	Increasing percentage of operators w/medical findings vs. angle of ulnar abudction (graphical presentation only)	Hunting *et al.*(1981: Ex. 26–1276)

TABLE V–11.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS OF THE NECK AND SHOULDERS WITH EXPOSURE TO NON-NEUTRAL POSTURE—Continued

Measure of posture	Health outcome/body region affected	Measure of effect	Reference
Relative angle of wrist ulnar or radial deviation/45–90 minute work sampling period.	Wrist	Linear regression coefficient [adj]: Mean relative deviation angle ($p<0.05$) Mean relative EMG signal ($p<0.05$) Seniority (years employed) ($p<0.05$)	Malchaire *et al.*(1996: Ex. 26–1473)
Wrist bending or twisting (mean hours/day) (5 categories).	Carpal tunnel syndrome	Odds Ratio [adj] 0: 1.0 0.25–1.75: 1.34(0.64–2.80) 2–3: 1.23(0.60–2.53) 3.5–6: 2.33 (1.24–4.36) 7–16: 2.47 (1.38–4.43) quadratic dose-response effect in alternative model, p=0.03	Nordstrom *et al.*(1997: Ex. 26–900)
Wrist deviation (3 categories of frequency).	Hand/wrist	Prevalence [unadj] (test of trend) None: 35% Some: 43% Frequent: 45% (p=0.43)	Stetson *et al.*(1993: Ex. 26–1221)
		Back	
Postural load (index of frequency and/or duration of 4 postures, in 4 categories).	Low back pain	Odds Ratio [adj] (test for trend)	Bovenzi *et al.*(1994: Ex. 26–774)
	Lifetime	Mild: 1.0 Moderate: 1.3(0.8–2.4) Hard: 1.7(1.0–3.0) Very hard: 3.6(2.0–6.5) (p=0.001)	
	12 month pervalence:	Moderate: 1.8 (1.1–3.2) Hard: 2.2(1.3–3.8) Very hard: 4.6 (2.6–8.0) (p=0.0001)	
Hands above should level (hours per day).	Low back (severe pain with impairment).	Prevalence Ratio [adj]: <1 hr: 1.1 0.8–1.5) 1–4: 1.5 (1.2–2.0) >4 hr: 1.6 (1.0–2.6)	Holmstrom *et al.*(1992: Ex. 500–41–65)
Stopping (hours per day)	Low back (severe pain with impairment).	Prevalence Ratio [adj]: <1 hr: 1.3 (0.9–1.8) 1–4 hr: 1.9 (1.4–2.6) >4 hr: 2.6 (1.7–3.8)	Holmstrom *et al.*(1992: Ex. 500–41–65)
Kneeling (hours per day)	Low back (severe pain with impairment).	Prevalence Ratio [adj]: <1 hr: 2.4 (1.7–3.3) 1–4 hr: 2.6 (1.9–3.5) >4 hr: 3.5 (2.4–4.9)	Holmstrom *et al.*(1992: Ex. 500–41–65)
Extreme work postures [factor formed from frequency and duration of trunk forward flexionn (>60°); frequency of trunk forward flexion (20°–60°); and duration of head rotation (>45°), trunk rotation (>45°), and work with hands above shoulders].	Low back (in blue collar workers)	Partial correlation coefficient [adj] 0.16 ($p<0.05$)	Johansson *et al.*(1994: Ex. 26–1331)
Monotonuous working movements [factor formed from duration of repetitive movements, static stress, and sitting].	Low back (in white collar workers	Partial correlation coefficient [adj] 0.22 ($p<0.05$)	Johansson *et al.*(1994: Ex. 26–1331)
Driving (hours/week)	Low back	Odds Ratio [adj] for prevalence: <10: 1.0 10–14: 1.5 (1.0–2.4) 15–19: 1.2 (0.8–1.9) 20–24: 2.0 (1.3–3.1) ≥ 25 2.1 (1.3–3.4)	Pietri *et al.*(1992: Ex. 29–309)

TABLE V–11.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS OF THE NECK AND SHOULDERS WITH EXPOSURE TO NON-NEUTRAL POSTURE—Continued

Measure of posture	Health outcome/body region affected	Measure of effect	Reference
Driving (hours/week)	Low back	Odds Ratio [adj] for 1 year cumulative incidence: <10: 1.0 10–14: 4.0 (1.1–14.3) 15–19: 4.8 (1.4.8–16.4) 20–24: 3.3 (0.9–12.0) ≥ 25 3.7 (0.9–14.0)	Pietri *et al.*(1992: Ex. 38–309)
Percentage of work cycle in trunk flexion (3 categories).	Low back	Odds Ratio [unadj] (test of trend) Mild flexion: 0%: 1.0 1–10%: 4.2 ≥10%: 6.1 (p=0.014) Severe flexion: 0%: 1.0 0–10%: 4.4 ≥10%: 8.9 (p=0.003)	Punnett *et al.*(1991: Ex. 26–1289)
Percentage of work cycle in non-neutral trunk posture (mild flexion, severe flexion, twist or lateral bend).	Back	Odds Ratio [adj] 8.09 (1.5–44.0)	Punnett *et al.*(1991: Ex. 26–1289)
Twisted or bent postures (4 categories).	Low back	Odds Ratio [adj] Rather or very little: 1.0 Moderate: 1.3 (1.0–1.7) Rather much: 1.5 (1.2–1.9) Very much: 1.5 (1.2–1.9)	Riihimåki *et al.* (1989: Ex. 26–58)
Forward bending (minutes per day)	Low back	Odds Ratio [adj]: Men 1–59 min: 1.6 (1.1–2.5) ≥60 min: 1.8 (1.1–3.1) Women 1–59 min: 1.1 (0.8–1.6) ≥60 min: 1.2 (0.7–1.8)	Vingård *et al.*(2000: Ex. 500–41–51)
Repeated bending, twisting, and reaching at work (hours per day.	Back	Odds Ratio [unadj] 0 hr: 1.0 >0–<2 hr: 5.8 2+–<4 hr: 8.4 4+–<6 hr: 10.4 6+ hr: 14.1 Odds Ratio [adj] per hour of repeated bending, twisting and reaching: 1.09 (1.06, 1.13)	Wild (Ex. 26–1106; 26–1107)
Frequent twisting or bending	Low back	Odds Ratio [unadj] (test of trend): No or seldom: 1.0 1/4 of the time: 1.8 1/2 of the time: 1.9 3/4 of the time: 2.0 All of the time: 2.0 (p<0.001)	Xu *et al.*(1997: Ex. 500–71–53)
Lower Extremity			
Knee-bending demand of job (3 categories: none, some, much).	Knee: radiographic osteoarthritis	Odds Ratio [adj] Men, ages 55–64: 2.5 (1.2–5.0) Women, ages 55–64: 3.5 (1.2–10.5)	Anderson *et al.*(1988: Ex. 26–926)
Kneeling and/or squatting (Floor- and carpetlayers 56%, carpenters 25%, compositors 0% of working time).	Knee	Odds Ratio [unadj] Compositors: 1.0 Carpenters: 3.9 (2.7–5.5) Floor- and carpetlayers: 6.4 (4.0–10.1)	Kirkeskov Jensen *et al.*[Jensen, 1977#1975]
Standing (hours per day)	Knee	Odds Ratio [adj]	Sandmark *et al.*(2000: Ex. 500–41–114)
	Men	Medium: 1.5 (0.9–2.4) High: 1.7 (1.0–2.9)	
	Women	Medium: 1.2 (0.7–1.9) High: 1.6 (1.0–2.8)	
Squatting or knee bending (number per day).	Knee	Odds Ratio [adj]	Sandmark *et al.*(2000: Ex. 500–41–114)
	Men	Medium: 1.3 (0.8–2.2) High: 2.9 (1.7–4.9)	

TABLE V–11.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIPS FOR MUSCULOSKELETAL DISORDERS OF THE NECK AND SHOULDERS WITH EXPOSURE TO NON-NEUTRAL POSTURE—Continued

Measure of posture	Health outcome/body region affected	Measure of effect	Reference
Kneeling (minutes per day)	Knee	Odds Ratio [adj]	Sandmark *et al.*(2000: Ex. 500–41–114)
	Men	Medium: 1.4 (0.9–2.2) High: 2.1 (1.4–3.3)	
Jumping (number per day)	Knee	Odds Radio [adj]	Snadmark *et al.*(2000: Ex. 500–41–114)
	Men	Medium: (0.9–2.4) High: 2.7)1.7–4.1)	
Jumping (number)	Hip	Odds Ratio [adj]	Vingard *et al.*(1977: Ex. 26–1617) Medium: 1.0 (0.5–2.0) High: 2.1 (1.1–4.2)
Stairs climbed (flights)	Hip	Odds Ratio [adj] Medium: 1.3 (0.8–2.0) High: 2.1 (1.2–3.6)	Vingard *et al.*(1997: Ex. 26–1616)

TABLE V–12.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIP FOR MUSCULOSKELETAL DISORDERS WITH EXPOSURE TO SEGMENTAL VIBRATION, BY BODY REGION AFFECTED.

Measure of vibration exposure (unit)	Health outcome/body region affected	Measure of effect	Reference
Vibration exposure (energy equivalent frequency-weighted acceleration) for 4 hours/day.	Upper extremity	Odds Ratio [adj] <7.5 m/sec^2 2.7 >7.5 m/sec^2 14.1 (p<0.005)	Bovenzi *et al.*(1991: Ex. 500–41–18)
Daily vibration exposure (energy equivalent frequency-weighted acceleration).	Upper extremity	Odds Ratio [adj] per unit 1.29 (p<0.5)	Bovenzi *et al.*(1991: Ex. 500–41–18)
Daily vibration exposure (energy equivalent frequency-weighted acceleration).	Upper extremity muscle-tendon syndrome.	Odds Ratio [adj] per unit 1.42 (p<0.5)	Bovenzi *et al.*(1991: Ex. 500–41–18)
Daily vibration exposure (energy equivalent frequency-weighted acceleration).	Carpal tunnel syndrome	Odds Ratio [adj] per unit 1.73 (p<0.5)	Bovenzi *et al.*(1991: Ex. 500–41–18)
Lifetime dose (5 categories of acceleration^2 years).	Hand-arm vibration syndrome	Odds Ratio [adj] per unit 0: 1.0 0–19: 4.1 (1.1–16.4) 19–20: 4.7 (1.3–16.1) 20–21: 9.4 (3.1–28.4) >21: 34.3 (11.9–99.0)	Bovenzi *et al.*(1991: Ex. 500–41–17)
Riveting (years)	Wrist	Odds Ratio [adj] per year 1.12 (p<0.05)	Burdorf *et al.*(1991: Ex. 500–41–21)
Riveting (years)	Hand-arm vibration syndrome	Odds Ratio [adj] per year 1.07 (p<0.05)	Burdorf *et al.*(1991: Ex. 500–41–21)
Power tool usage	Forearm-hand (right)	Median values for workstations with high vs. low symptom prevalence [unadj] Holding time: 12 sec. vs 6 secs. (p<0.05) Total duration: 21 sec. vs 15 secs. (p<0.05)	Fransson Hall *et al.*(1996: Ex. 500–41–56)
Years of exposure to vibration (chain saw use).	Vibration-induced white finger	Positive association with duration of exposure Higher prevalence and earlier onset of symptoms with earlier first exposure (higher acceleration levels) (all data presented graphically)	Futatsuka *et al.*(1985: Ex. 26–1430)

TABLE V–12.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIP FOR MUSCULOSKELETAL DISORDERS WITH EXPOSURE TO SEGMENTAL VIBRATION, BY BODY REGION AFFECTED.—Continued

Measure of vibration exposure (unit)	Health outcome/body region affected	Measure of effect	Reference
Cumulative hours of exposure to vibration.	Median and ulnar motor and sensory nerve function.	Correlation coefficient [unadj] R median motor NCV: 0.274 (p=0.01) L median motor NCV: 0.123 (p>0.05) R ulnar motor NCV: 0.259 (p=0.05) L ulnar motor NCV: 0.389 (p>0.001) R median distal latency: 0.172 (p=0.05) L median distal latency: 0.214	Koskimies *et al.*[Koskimies, 1990 #1983]
Cumulative exposure to vibration (log hours).	Hand-arm vibration syndrome:	Odds Ratio [adj] per common log unit	Letz *et al.*(1992: Ex. 26–384)
	Vascular	2.9 (1.7–5.0)	
	Sensorineural	1.8 (1.2–2.9)	
Tool use (years)	Hand-arm vibration syndrome (Stockholm workshop scales):.	Odds ratio [adj] per year	McGeoch *et al.*(2000: Ex. 500–41–96)
	Neurological stage ≥ 1	1.09 (p<0.05)	
	Vascular stage ≥ 1	1.10 (p<0.05)	
Years of exposure to vibration	Hand-arm vibration syndrome	Odds ratio [adj] per year 1.11 (1.05–1.17)	Nilsson *et al.* (1989: Ex. 26–1148)
Years of exposure to vibration	Median nerve latency at carpal tunnel.	Odds ratio [adj] per year Right: 1.12 (1.02–1.23) Left: 1.09 (1.00–1.20)	Nilsson *et al.*(1994: Ex. 26–1190)
Cumulative vibration exposure (3 categories: 0–8999; 9000–255,199; and >255,199 energy-weighted hours).	Shoulder: osteoarthritis of the acromioclavicular joint.	Odds Ratio [adj] (per category) Right side: 1.3 (0.9–1.8) Left side: 1.8 (1.2–2.6)	Stenlund *et al.*(1992: Ex. 26–733)
Cumulative vibration exposure (3 categories: 0–8999; 9000–255,199; and >255,199 energy-weighted hours).	Shoulder tendinitis	Odds Ratio [adj] (per category) Right side: 1.7 (1.1–2.6) Left side: 1.8 (1.1–3.1)	Stenlund *et al.*(1993: Ex. 502–462)

TABLE V–13.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIP FOR MSDS WITH COMBINATION OF EXPOSURES (*e.g.,* REPETITION, FORCE AND POSTURE), BY TYPE OF EXPOSURE AND BODY REGION AFFECTED.

Exposure factors	Health outcome/body region affected	Measure of effect	Reference
Index of physical stress at work (sum of 6 items).	Neck	Odds Ratio [adj] Age 30–64 years: 1.26 (1.18–1.33) Age ≥ 65 years: 1.12 (1.00–1.26)	Mäkelä *et al.*(1991: Ex. 26–980)
Index of mechanical workload (sum of 6 items).	Elbow: epicondylitis	Odds ratio [adj]: Model 2: 1.5 (1.0–2.3) Model 3: 1.7 (1.2–2.6)	Ono *et al.*(1998: Ex. 500–66–4)
Repetition; force (4 categories: LF = low force; LR = low repetition; HF = high force; HR = high repetition.	Hand/wrist: tendinitis	Prevalence Rate Ratio [unadj] LF LR: 1.0 HF LR: 4.8 (0.6–39.7) LF HR: 5.5 (0.7–46.3) HF HR: 17.0 (2.3–126.2)	Armstrong *et al.*(1987: Ex. 26–48)
Work at video display unit, with and without specific job features.	Arm/hand	Odds Ratio [adj] Data entry: 1.5 (0.7–3.4) Data entry plus keyboard too low: 2.8 (0.9–8.6) ≥ 20 hr/week: 0.5 (0.2–1.4) ≥ 20 hr/week plus limited rest breaks, no lower arm support: 4.6 (1.2–17.9)	Bergqvist *et al.*(1995: Ex. 26–1195 500–165–25)
Work at video display unit, with and without specific job features.	Arm/hand	Odds Ratio [adj] Limited rest breaks, plus no lower arm support, vs. one or neither: 10.1 (2.4–43.2)	Bergqvist *et al.*(1995: Ex. 500–165–24)

TABLE V–13.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIP FOR MSDS WITH COMBINATION OF EXPOSURES (*e.g.,* REPETITION, FORCE AND POSTURE), BY TYPE OF EXPOSURE AND BODY REGION AFFECTED.—Continued

Exposure factors	Health outcome/body region affected	Measure of effect	Reference
Force and repetition of hand activities (5 classes, from very light/ low to very heavy/high).	Hand: Median nerve sensory conduction velocity.	Test of positive linear trend: $p < 0.01$	Nathan *et al.*(1988: Ex. 26–990)
Force and repetition of hand activities (5 classes, from very light/ low to very heavy/high).	Hand: Median nerve sensory conduction velocity.	Linear regression coefficient [adj]: Class of hand activity: 0.011 ($p < 0.05$)	Nathan *et al.*(1992: Ex. 26–988)
Index of physical risk factors (sum of 3 items: force; 1 kg, cycle time < 30 sec, static hand work).	Hand: Radial tunnel syndrome	P <0.001, test for trend	Roquelaure *et al.*(1996: Ex. 500–41–111)
Index of physical risk factors (sum of 5 occupational items plus parity ≥ 3).	Hand: Carpal tunnel syndrome	Odds ratio [adj] ≤ 2 factors: 1.0 3 factors: 5.6 (1.6–24.5) 4 factors: 93.7 (13.4–93.8) ≥ 5 factors: 90.0 (8.0–366.5)	Roquelaure *et al.*(1997: Ex. 38–396)
Repetition; force (4 categories: LF = low force; LR = low repetition; HF = high force; HR = high repetition).	Hand/wrist	Odds Ratio [adj] LF LR: 1.0 HF LR: 5.2 LF HR: 3.3 HF HR: 29.1 ($p < 0.05$)	Silverstein *et al.*(1986: Ex. 26–1404)
Repetition; force (4 categories: LF = low force; LR = low repetition; HF = high force; HR = high repetition).	Hand: Carpal tunnel syndrome	Odds Ratio [adj] LF LR: 1.0 HF LR: 1.8 LF HR: 2.7 HF HR: 15.5 ($p < 0.001$)	Silverstein *et al.*(1987: Ex. 26–34)
Repetitiveness and forceful exertions of the upper limbs (Group I = neither, Group II = either, Group III = both).		Test of positive linear trend:	Chiang *et al.*(1993: Ex. 26–1117)
	Neck symptoms	p = 0.04	
	Shoulder symptoms	p = 0.000	
	Shoulder girdle diagnosis	p = 0.000	
	Elbow symptoms	p = 0.11	
	Epicondylitis	p = 0.14	
	Wrist symptoms	p = 0.03	
	Hand symptoms	p = 0.04	
	Carpal tunnel syndrome	p = 0.02	
Index of ergonomic stressors (sum of 9 items, range 0–25).	Upper extremity (neck, shoulder/ upper arm, elbow/forearm, and/ or hand/wrist).	Prevalence ratio [adj] 0–6: 1.0 7–12: 2.0 (1.2–3.4) 13–18: 2.6 (1.6–4.3) 19–25: 2.8 (1.6–4.8)	Punnett (1998: Ex. 26–38)
	Shoulder/upper arm	0–6: 1.0 7–12: 2.6 (1.1–6.2) 13–18: 3.6 (1.6–8.3) 19–25: 3.3 (1.3–8.3)	
	Wrist/hand	0–6: 1.0 7–12: 1.9 (1.0–3.8) 13–18: 2.4 (1.3–4.7) 19–25: 2.3 (1.1–4.7)	
Index of occupational physical stress (sum of 5 items, range 0–5).	Low back	Odds Ratio [adj]: 0: 1.0 1: 1.2 (0.9–1.6) 2: 1.7 (1.3–2.1) 3: 2.1 (1.6–2.7) 4: 3.2 (2.3–4.5) 5: 2.5 (1.4–4.7)	Heliovaara *et al.*(1991: Ex. 26–959) Lifting >11.3 kg while twisting Low back: Prolapsed lumbar disc Odds Ratio [adj]: Knees bent: 2.7 (0.9–7.9) Knees straight: 6.1 (1.3–27.9) Kelsey *et al.*(1984: Ex. 500–41–73)
Lifting > 11.3 kg while twisting	Low back: Prolapsed lumbar disc	Odds Ratio [adj] Knees bent: 2.7 (0.9–7.9) Knees straight: 6.1 (1.3–27.9)	Kelsey *et al.*(1984: Ex. 500–41–73)
Physical exposure index (sum of 3 items, range 0–3.	Low back	Odds Ratio [adj]: 0: 1.0 1: 1.41 (1.02–1.94) 2: 2.45 (1.63–3.68) 3: 3.18 (1.72–5.81)	Liira *et al.*(1996: Ex. 26–748)
Forward bending and manual materials handling (MMH) (highly exposed now, 5 and 10 years ago).	Low back	Odds Ratio [adj]:	Vingard *et al.*(2000: Ex. 500–41–51)

TABLE V–13.—EVIDENCE OF EXPOSURE-RESPONSE RELATIONSHIP FOR MSDS WITH COMBINATION OF EXPOSURES (*e.g.,* REPETITION, FORCE AND POSTURE), BY TYPE OF EXPOSURE AND BODY REGION AFFECTED.—Continued

Exposure factors	Health outcome/body region affected	Measure of effect	Reference
		Men Forward bending: 1.8 (1.0–3.3) MMH: 2.0 (1.0–4.3) Bending and MMH: 2.8 (1.1–7.5) Women Forward bending: 1.5 (0.8–2.6) MMH: 1.1 (0.6–2.1) Bending and MMH: 2.9 (1.2–6.8)	
Kneeling, squatting or stair-climbing, with and without heavy lifting.	Knee osteoarthritis	Odds Ratio [adj]: Neither kneeling nor lifting: 1.0 Kneeling/squatting: 2.5 (1.1–5.5) Kneeling and lifting: 5.4 (1.4–21.0)	Cooper *et al.*(1994: Ex. 500–41–27)
Kneeling, with (floor layers) and without (tile/terrazzo setters) use of knee kicker.	Knee: bursitis	Prevalence ratio [adj]: Floor layers: 3.2 (1.9–5.4) Tile setters: 1.8 (0.8–3.9)	Thun *et al.*(1987: Ex. 26–60)

In a cross-sectional study of newspaper workers, the risk of both neck and shoulder disorders increased with typing speed and with percentage of time working at the keyboard (Burt *et al.,* 1990: Ex. 26–698). Similarly, several investigators have shown exposure-response relationships for neck and shoulder disorders among video display unit operators with the number of hours per day (or week) of VDU work (Bergqvist *et al.,* 1995: Exs. 26–1195, 500–165–25; Faucett *et al.,* 1994: Ex. 38–256; Rossignol *et al.,* 1987: Ex. 26–804).

Two different studies of sewing machine operators in the garment industry have shown increasing prevalence of neck and shoulder disorders with cumulative years of exposure to repetitive work (Andersen *et al.,* 1993: Ex. 26–1451; Andersen *et al.,* 1993: Ex. 26–1502; Schibye *et al.,* 1995: Ex. 26–1463). (Note that Andersen 1993a (Andersen *et al.,* 1993: Ex. 26–1451) computed both crude and adjusted odds ratios, and the latter estimates were higher. However, in the adjusted model, each of the potential confounders had little association with the risk of neck/shoulder syndromes, so this model was deemed overly conservative and statistically inefficient, and the unadjusted ORs are shown in the table.) Andersen *et al.,* (Andersen *et al.,* 1993: Ex. 26–1502) also computed chi-square tests of trend with exposure for specific diagnoses. The following had a positive trend with years of exposure: cervicobrachial fibromyalgia ($p<<0.001$); rotator cuff syndrome ($p<0.01$); and cervical syndrome ($p<0.001$). The probability of having no MSD symptoms showed a negative trend with years of exposure ($p<0.001$). These findings are compatible with those of Brisson *et al.,* (Brisson *et al.,* 1989: Ex. 26–937), who examined long-term musculoskeletal disability in general, and specifically that due to arthritic and back disorders, including regular pain in the lower back, upper back/neck, shoulders, hands/wrists/elbows, or knees/ankles. The risk of long-term disability, both overall and for musculoskeletal disorders, increased with years of piece-rate garment work.

Elbow and forearm disorders are typically less prevalent, so there are fewer opportunities to evaluate exposure-response relationships with adequate statistical power. Nevertheless, several studies of VDU operators have shown such associations with speed or daily duration of VDU work (Bergqvist *et al.,* 1995: Ex. 26–1195, 500–165–25; Burt *et al.,* 1990: Ex. 26–698; Rossignol *et al.,* 1987: Ex. 26–804).

Intensity and duration of VDU work have shown similar exposure-response relationships with disorders of the hand and wrist region, including carpal tunnel syndrome (Bernard *et al.,* 1994: Ex. 500–165–21; Burt *et al.,* 1990: Ex. 26–698; Faucett *et al.,* 1994: Ex. 38–256), as well as with cases that include both proximal and distal regions of the upper extremity (Knave *et al.,* 1985: Ex. 26–753; Oxenburgh, 1987: Ex. 26–1367; Polanyi *et al.,* 1997: Ex. 500–41–106).

In the manufacturing sector, there is also evidence that the risk of hand and wrist disorders increases with work pace and repetitiveness (Latko *et al.,* 1999: Ex. 38–171; Leclerc *et al.,* 1998: Ex. 500–41–85) and with cumulative years of exposure to repetitive manual work (Ohlsson *et al.,* 1989: Ex. 26–1290; Wieslander *et al.,* 1989: Ex. 26–1027). Moore *et al.,* (Moore *et al.,* 1994: Ex. 26–1033) showed that the risk of reported upper extremity disorders decreased with the percentage of recovery time in each work cycle.

Force

Forceful manual exertions have been characterized by different investigators with a variety of metrics, some of them involving the combination of at least two of object weight, frequency of handling, and duration of exposure. These various approaches have yielded evidence of the risk of shoulder disorders increasing with exposure in white collar, construction, and manufacturing jobs (Hughes *et al.,* 1997: Ex. 26–907; Johansson *et al.,* 1994: Ex. 26–1331; Stenlund *et al.,* 1993: Ex. 502–462), and similar evidence for elbow disorders, even though limited by the smaller numbers of cases mentioned above (Hughes *et al.,* 1997: Ex. 26–907; Ritz, 1995: Ex. 26–1473).

Among grocery store workers, grocery checking has been identified as a job requiring forceful exertions. In two different studies, the risk of shoulder, elbow, and wrist/hand disorders, including CTS, was associated with the level of forcefulness required by each employee's job, the number of hours of checking work per week, and the cumulative number of years of checking (Baron *et al.,* 1991: Ex. 26–697; Osorio *et al.,* 1994: Ex. 26–807). Note that Osorio *et al.* defined three categories of exposure, but there were no CTS cases in the low exposure group, so in multivariate modeling only the odds ratio for low/medium vs. high exposure could be calculated. These dichotomous estimates, adjusted for age, gender, medical history and alcohol consumption, ranged from 6 to 40.

In other studies of hand and wrist disorders, exposure-response relationships have been found for finger flexor forces, measured by electromyography, as well as for simpler estimates of force based on object weight and on self-report. In particular, these showed trends in risk of CTS that are compatible with the experimental evidence, as summarized recently by Viikari-Juntura and Silverstein (Viikari-Juntura *et al.,* 1999: Ex. 500–121–73).

There is a particularly large number of studies demonstrating that the risk of back disorders, including prolapsed lumbar disc, increases with the frequency or duration of manual material handling, with load weights, and with other indicators of physically strenuous work including but not limited to lifting and carrying tasks. Again, exposure has been variously characterized on the basis of observation, self-report, and bio-instrumentation measures and/or combined into indices. The volume of evidence is extremely impressive and demonstrates that such exposure-response relationships have been found in nursing and other health care work, in construction, in manufacturing, and in the wide range of jobs encountered in the general population. For example, Venning *et al.* (Venning *et al.,* 1987: Ex. 500–41–49) published a prospective study of a closed cohort, which showed the predictive value of work area classified *a priori* in terms of lifting demands. Kerr, Norman, and colleagues (Kerr *et al.,* Ex. 500–41–74 ; Norman *et al.,* 1998: Ex. 38–84) compared cases to controls on 12 continuous biomechanical variables, representing both peak and daily integrated load on the spine. There was a higher load in the cases by each variable (all p-values < 0.04). There was a moderate amount of correlation among these variables, so the final regression model was reduced to four, with adjustment for demographic and psychosocial factors. The odds ratios, computed both for full observed ranges of exposure and more conservatively for inter-quartile spreads, showed that several dimensions of load on the lumbar spine made independent contributions to risk of back disorders.

It is of particular interest that three different studies (Marras *et al.,* 1993: Ex. 500–41–94 ; Wang *et al.,* 1998: Ex. 500–41–52; Waters *et al.,* 1999: Ex. 500–121–76) showed such a relationship when lifting demands were characterized using the NIOSH lifting index (Waters *et al.,* 1993: Ex. 26–521). (It should be noted that Waters *et al.* (Waters *et al.,* 1999: Ex. 500–121–76) also estimated the odds ratios in a multivariate logistic regression model that included nine other covariates. These estimates so obtained were higher for the category of LI=1–2 and otherwise lower than the crude estimates. However, 7 of the covariates in the model had little association with LBP, so this model was deemed overly conservative and the unadjusted ORs were selected as summary measures of the study results.)

Studies of other, related health outcomes, including knee arthritis and ''overexertion incidents'' of any body part, provide compatible findings regarding the effects of strenuous work. In addition, Krause *et al.* (Krause *et al.,* 1997: Ex. 26–1281) found that disability retirement was increasingly frequent from jobs with heavy physical demands and also showed an exposure-response trend with an index of repetitive strain that included lifting demands, muscle effort, and non-neutral postures. The cases of disability retirement were due to any medical condition; however, a large proportion was caused by musculoskeletal conditions (see Table 2 of (Krause *et al.,* 1997: Ex. 26–1281)).

Posture

Studies of the effect of non-neutral postures also include a wide range of exposure measures, including estimated frequency or duration of specified postures, as well as tasks that imply specific postural demands (*e.g.,* driving as an indicator of highly constrained static sitting) and workstation characteristics that directly influence posture (*e.g.,* VDU keyboard too high). Since the anatomic segments of the body form a kinematic chain, non-neutral postures may affect not only the same joint region but also other joints along that chain. For example, if the work layout requires the trunk to be twisted while the eyes are facing forward, the neck will also be twisted and health effects may be found all along the spine. Work with the arms elevated may alter wrist posture or impose a biomechanical disadvantage on the arm muscles; it will increase the torque exerted by an object held in the hands, which in turn increases the compressive forces experienced in the lumbar spine (Chaffin *et al.,* 1991: Ex. 26–420).

There are a very large number of studies showing that neck and shoulder disorders exhibit an exposure-response relationship with arm and neck postures, especially arm elevation to form an included angle of at least 30° flexion or abduction. Both Bergqvist *et al.* (Bergqvist *et al.,* 1995: Ex. 500–165–24) and Faucett *et al.* (Faucett *et al.,* 1994: Ex. 38–256) showed an increasing risk as the height of the VDU keyboard increased relative to seated elbow height. In a case-control study within a single automobile assembly plant, Punnett and colleagues found an increasing risk of shoulder disorders with the observed proportion of the work cycle in which the included angle at the shoulder was at least 90 degrees (Punnett *et al.,* 2000: Ex. 500–41–109). This association was not confounded by gender or other demographic or medical history factors.

Viikari-Juntura *et al.* (Viikari-Juntura *et al.,* 2000: Ex. 500–41–50) carried out a longitudinal study with four repeated questionnaires among 5180 workers in a large forest industry enterprise. The authors used a modified Nordic questionnaire (Kuorinka *et al.,* 1987: Ex. 38–204) for the health outcome of '' radiating neck pain'' and validated exposure assessment and psychosocial questionnaires. There was a statistically significant dose-response relationship for radiating neck pain with the frequency of ''twisting movements of the trunk during a work day'' (ORs from 1.0 to 2.3), as well as a dose-response relationship for hands above the shoulder. These estimates were adjusted for body mass index and high mental stress.

English *et al.* conducted a study of patients in the general population seeking medical care for upper extremity disorders (English *et al.,* 1995: Ex. 26–848). Conditions affecting the wrist and hand showed exposure-response relationships with several different shoulder and wrist postures (Table 3b). The degree of ulnar deviation has been reported to be associated with the risk of forearm and wrist disorders (Hunting *et al.,* 1981: Ex. 26–1276; Malchaire *et al.,* 1996: Ex. 26–1473). Several authors have found that the risk of carpal tunnel syndrome increases with the number of hours per day or week in which the wrist is flexed or extended (Blanc *et al.,* 1996: Exs. 26–42, 500–41–16; de Krom *et al.,* 1990: Ex. 26–102; Nordstrom *et al.,* 1997: Ex. 26–900).

In studies of back disorders, a number of investigators have reported exposure-response relationships with trunk forward flexion, lateral bending, and rotation. These studies address non-neutral postures in both seated and standing work, and they cover a range of industries and occupations from tractor driving to construction to automobile assembly. Similar data for the U.S. general population were obtained from analysis of the National Health Interview Study (Exs. 26–1106, 26–1107). There is also evidence of increasing risk with static sitting, both assessed directly and through estimated time or distance driving per week (although the latter may also involve exposure to whole-body vibration). In the study by Pietri *et al.* (Pietri *et al.,* 1992: Ex. 38–309), the odds ratios for both prevalence and one-year cumulative incidence of low back pain showed increases with hours of driving per week in multivariate models adjusted for age, gender, comfortable car seat (y/n), carrying loads (y/n), standing (y/n), tobacco consumption, and psychosomatic factors.

With regard to disorders affecting the lower extremity, knee-bending, kneeling, squatting, jumping from one level to another, and stair-climbing are all found in these studies. In a series of Danish studies, direct observations showed that the average proportion of time that was spent kneeling and/or squatting by workers in three different trades (Jensen *et al.,* 1997: Ex. 500–41–69). The prevalence of knee disorders among the same three trades increased proportionately to the exposure prevalences. Anderson and Felson utilized the U.S. Department of Labor Dictionary of Occupational Titles and characterized each occupation on the basis of the proportion of job titles within it that required knee-bending (0%, up to 50%, more than 50%) (Anderson *et al.,* 1988: Ex. 26–926). Among subjects aged 55 to 64 years, there was a two to three-fold increase in risk of radiographic osteoarthritis with each category of knee-bending, adjusted for gender, race, education, and body mass index. These odds ratios represent the increase in risk across the three categories, *i.e.,* from no to some and from some to much knee-bending.

Vibration

Segmental vibration exposure to the distal upper extremity, especially through holding and operating power tools, is another area of research where exposure-response relationships have been reported by numerous authors. Some studies have shown the association with years of exposure, and others combined work history with direct measurements of frequency and acceleration to construct biologically informed cumulative exposure indices. Most of the evidence concerns neurological and circulatory impairment of the hand and wrist. Three different investigations reported an odds ratio of about 1.1 for each year of occupational exposure to hand-arm vibration, which represents a doubling of risk about every 7 years. In addition to those studies shown in Table 4a, Nordstrom *et al.* (Nordstrom *et al.*, 1997: Ex. 26–900) reported an ''alternative'' multivariate model of CTS in which there was a positive quadratic dose-response relationship (p=0.01) for use of power tools or machinery. While this variable was not conclusive regarding exposure to segmental vibration, it does suggest an exposure-response trend between segmental vibration and CTS.

In an historical cohort, Futatsuka *et al.* (Futatsuka *et al.*, 1985: Ex. 26–1430) found a positive association between the prevalence of ''vibration-induced white finger'' and the duration of exposure to vibration (chain saw use). In addition, there was an interaction with year of first exposure: higher prevalences and earlier onset of symptoms were observed among workers with earlier first exposure, when the acceleration levels were higher (all data presented graphically). One study team found similar associations for the risk of shoulder disorders (Stenlund *et al.*, 1993: Ex. 502–462; Stenlund *et al.*, 1992: Ex. 26–733).

Several statements contained in submissions by the Chamber of Commerce and others cited OSHA's statement in the preamble to the proposal that it had not constructed ''generalized quantitative exposure-response relationships'' for standard-setting (64 Fed. Reg. at 65927), and that the Agency's reluctance to set permissible exposure levels for risk factors provided evidence of a lack of exposure-response relationship in the epidemiologic literature (*e.g.*, Chamber of Commerce, Ex. 30–1722, p. 46 and Ex. 500–188, pp. 10–11; United Parcel Service, Ex. 500–197, pp. I–61 to I–62). Such arguments confuse exposure-response relationships *as evidence of a causal relationship* with the last stage of *quantitative risk assessment*, namely computation of a permissible exposure level.

It is critical to distinguish between these points. Exposure-response relationships have been demonstrated in the epidemiologic literature, using a variety of exposure metrics and for a variety of health outcomes, and a number of reviewers have cited this evidence in concluding that there are causal relationships (eg., Armstrong *et al.*, 1993: Ex. 26–1110; Bernard, 1997: Ex.26–1; Burdorf *et al.*, 1997: Ex. 500–121–13; Hagberg *et al.*, 1992: Ex. 8–1; Hales *et al.*, 1996: Ex. 26–896; Viikari-Juntura *et al.*, 1999: Ex. 500–121–73). At the same time, although the indicted exposures and their associations with MSDs are qualitatively similar across many studies, the variations in measurement approaches results in very limited numbers of studies with any single exposure metric. More importantly, there is substantial evidence of interactions among physical exposures, so that (for example) jobs requiring both repetitive and forceful motions have a higher risk than jobs requiring either exposure alone (Armstrong *et al.*, 1987: Ex. 26–48; Silverstein *et al.*, 1986: Ex. 26–1404; Silverstein *et al.*, 1987: Ex. 26–34). (Numerous examples of other additive or multiplicative effects between physical ergonomic exposures have been listed in Tables V–9 through V–13). Thus, the exposure-response curve for each exposure should ideally be described as a function of the level of *each* other exposure that might also be present in the same job. This represents an enormous number of *combinations* of exposure, of which only some have been studied epidemiologically to date. Given the available exposure-response relationships, plus evidence that exposures interact with each other, the decision not to attempt quantitative risk assessment calculations at this time is readily justifiable. However, this does not at all imply that the evidence for exposure-response relationships is insufficient to conclude that there is a causal relationship between exposure to risk factors and the risk of MSDs.

Another argument made in the testimony cited above is that if an exposure-response relationship existed, it would necessarily be linear or monotonic, and that it would necessarily provide an exposure level that could be used to differentiate between background risk of MSDs and an elevated risk (United Parcel Service, Ex. 500–197, pp. I–62 to I–67). This assertion is false. An exposure-response relationship need not take the form of a straight line through all data points; it may conceivably be better described as a logistic curve, or as a step-function, or as any other of a variety of mathematical functions. As one example, the analyses presented by Frost *et al.* (Frost *et al.*, 1999: Ex. 38–97) clearly show a non-linear exposure-response trend with cumulative exposure to repetitive and loaded shoulder flexion. Two among many other illustrations of non-linear, positive exposure-response relationships can be found in Liles *et al.*, 1984 (Liles *et al.*, 1984: Ex. 26–33 500–41–88), where the authors suggested that their graphs provided evidence of exposure thresholds, and Moore *et al.*, 1994 (Moore *et al.*, 1994: Ex. 26–1033), where a log-log transformation improved the fit of the model. A non-linear relationship, for example, accommodates the likelihood that some physical activity is beneficial and that only at more extreme levels do adverse health effects occur, a point advanced by several in their testimony to the docket (*e.g.*, United Parcel Service, Ex. 500–197, pp. I–68; Vender attachment to UPS post-hearing comments, Ex. 500–118, page 17). Dr. Hadler opined that ''whenever a relationship between exposure and effect is not linear (not monotonic), you can be sure there are confounders, * * *.'' (Hadler attachment to UPS post-hearing comments, Ex. 500–118, page 4). He offered no evidence in support of this assertion, and in fact there is no requirement in epidemiology that the relationship must either be linear or monotonic. OSHA has relied on non-linear dose-response relationships in other health standard rulemakings (see Formaldehyde, 54 FR46168, Cadmium 57 FR 42101).

Second, most exposure-response relationships do not indicate a single exposure level that unambiguously differentiates risk from no risk. This is *especially* true if exposure is treated as continuous and the relationship fits a straight line through the origin, in which case each small increment in exposure increases the probability of an adverse health outcome and, extrapolated downward, there may be no discernable point without excess risk above the zero exposure level. Note that in this regard U.P.S. criticized OSHA for the assumption that, in fact, *UPS* had made: ''OSHA has falsely assumed that any increment of human muscle usage is harmful, * * *.'' (United Parcel Service, Ex. 500–197, pp. I–68).

On the other hand, when exposures have been categorized and are ordinally associated with risk of disease, it can be argued that the first exposure level where an elevated risk is observed above baseline represents an appropriate point for a permissible exposure level (at least until subsequent studies clarify whether there is still excess morbidity occurring below that level). This type of approach was taken recently by the American Conference of Governmental Industrial Hygienists (2000), which used essentially the same epidemiologic evidence available to OSHA—with its variety of exposure metrics—to determine the proposed new Threshold Limit Value® for occupational hand activity level (see Exs. 38–162, DC–387).

Several authors have called attention to the complexity of the process of utilizing exposure-response data for quantitative risk assessment in the multi-dimensional domain of physical ergonomics (*e.g.*, Armstrong *et al.*, 1993: Ex. 26–1110; Burdorf *et al.*, 1997: Ex. 500–121–13; Frank *et al.*, 1996: Ex. 502–407; Kilbom, 1999: Ex. 38–406; Viikari-Juntura *et al.*, 1999: Ex. 500–121–73). OSHA finds that it is reasonable to conclude, as these experts have done, that there is a need for continuing study of those relationships and interactions, while at the same time, that it is appropriate to implement the scientific knowledge in hand in order to reduce the risk of work-related MSDs.

In the preamble to the proposed rule (64 FR 65768), OSHA presented the results of several studies that provided evidence for positive trends between exposure to biomechanical risk factors and the prevalence or incidence of MSDs. Three commenters critiqued twelve of these studies, claiming a variety of design or methodological flaws in the studies, computational errors in the studies, or that OSHA misused some of the data (Exs. 30–276, 500–79, 32–241–4). The comments are those of Dr. Steven Moore, Professor, Environmental and Occupational Health, Texas A&M University (Ex. 30–276), Marathon Ashland Petroleum LLC (Ex. 500–79), and Gibson, Dunn & Crutcher (Ex. 32–241–4). Marathon Ashland Petroleum LLC includes Dr. Moore's comments as an Appendix. Gibson, Dunn & Crutcher summarize the critiques of several experts, whose statements are attached to their comment. OSHA responds to all these comments below.

Dr. Moore and Gibson, Dunn & Crutcher criticized the study on risk factors for CTS by deKrom *et al.*, (1990, Ex. 500–41–28). They claim that the study does not account for psychosocial factors and that it is methodologically flawed in relying on self-reported information about duration of exposure, rendering the results meaningless. With respect to the lack of analysis on psychosocial factors, OSHA acknowledges that this case-control study, with cases mostly of hospital outpatients and controls from the general population, did not examine or control for psychosocial factors. However, OSHA finds nothing in the design and analysis of this study that would invalidate the statistically significant positive associations among work related physical factors and CTS that the study did find. The authors concluded that activities with a flexed wrist or with an extended wrist (exposure-related increased ORs) were risk factors for CTS. Dr. Moore criticized the duration analysis used to estimate exposure-response as a function of time, claiming that the survey questionnaire instrument for collecting exposure information was unreliable. OSHA responds that with little information about the survey questionnaire in the published paper, the agency cannot determine the reliability. However, from a description in the paper of the blindness with which the survey was administered, OSHA believes that such an imperfect exposure measurement instrument would yield non-differential exposure misclassification. Such non-differential misclassification would bias both the ORs and the slope toward a finding of no increasing trend. The fact the deKrom *et al.* study found statistically significant ORs for each incremental number of weekly hours of activities with extended or flexed wrist separately, plus finding a statistically significant exposure-response trend for both duration variables, despite the negative bias, provides strong evidence that the effect is real. This finding is further strengthened by the final analysis of de Krom *et al.* which used a multiple regression model simultaneously containing both duration of ''flex'' and ''extended'' wrist activities as variables, with both variables found to be statistically significant for duration-of-exposure-response trends (Ex. 500–41–28, pg. 1108). The finding of joint statistical significance of collinear variables when simultaneously modeled increases confidence in the significance of the separate variables.

OSHA also responds to the criticism that ''in a conclusion that would devastate OSHA's attempt to redesign the American office, [deKrom *et al.*] found no significant risk of CTS related to typing.''OSHA notes that of the 156 cases of CTS, only 12 cases reported any work-related typing at all. In a case-control study such as this with only 12 cases exposed to typing, the statistical ability to determine a significant result is very small. Either a different study recruitment procedure or a much larger sample size would be required. With respect to another criticism by Gibson, Dunn & Crutcher on the apparently spurious finding of an association of CTS with varicosis in men, the authors reported this result of their analysis for the scientific world to contemplate, but found it inconsistent with that of other authors (Ex. 32–241–4).

Dr. Moore also criticizes OSHA's use of the MSD prevalence study by Luopajarvi *et al.*, (1979, Ex. 26–56) used as part of the agency's determination of causality for hand/wrist tendinitis. Dr. Moore claims the study's poor exposure assessment and lack of statistical comparisons provide poor support. In response, OSHA notes that the same exposure assessment methods were used in the study comparisons between the assembly-line packers and the shop assistants, so that the differences should be unaffected. OSHA also notes that these comparison showed that the assembly-line packers had a highly statistically significant (p<0.001) increased prevalence of (1) syndromes found in the neck, shoulders and elbows; and (2) muscle-tendon syndromes in the hands (p<0.001). The most common neck syndrome in this study was tension neck and the most common shoulder disorder was humeral tendinitis. For hands, Luopajarvi *et al.* noted the prevalence of tenosynovitis/peritendinitis at 53% in the assembly-line packers, but only 14% in the shop-assistants (who endured prolonged standing, but otherwise physically light work). For the assembly-line packers the authors noted especially the repetitive motions at a high speed, and fingers and hands constantly used at the pace of the machine, up to 25,000 cycles per workday. For these packers the authors also noted difficult static muscle work, extreme work positions of the hands, and difficult lifting. OSHA believes that this study provides a good comparison between similar demographic groups, and that it provides good evidence that work-related physical stress factors were causing shoulder and upper extremities injuries.

Dr. Moore also claims that errors in the evaluations of two other studies are materially related to the NIOSH's and OSHA's conclusions (Ex. 30–276, pg. 2). With respect to the study by Kuorinka and Koskinen, he criticizes NIOSH for not specifically mentioning the ''non-positive'' finding of no evidence of association of with time spent in deviated wrist postures per day. OSHA responds that the Kuorinka and Koskinen study did not specifically mention peritendinitis and tenosynovitis in its analysis, only the total complex of muscle-tendon syndrome. Their definition of muscle-tendon syndrome used in this study came from an accompanying article they coauthored in the same journal (see Ex. 26–1218); the definition included syndromes of the shoulder and elbow, along with the wrist and hands. Every one of the seventeen (out of 93) manual workers with muscle-tendon syndrome also had tension neck syndrome, but none was specifically identified as having either peritendinitis or tenosynovitis (Ex. 26–639). While Dr. Moore is correct that Kuorinka and Koskinen found no correlation between the number of signs in the wrist and the deviation load of the wrist joint (1979, Ex. 26–639). OSHA finds too few details in the analysis for any conclusions with respect to peritendinitis and tenosynovitis.

Dr. Moore also criticizes the NIOSH 1997 (Ex. 26–1) review for its failure to include the findings of a second study, Armstrong *et al.*, (1987, Ex. 500–41–4) in NIOSH's evaluation on the effect of posture for hand/wrist tendinitis. Dr. Moore claims that NIOSH rated the Armstrong *et al.* study as high quality for other physical risk factors (*i.e.* force and repetition, for which the study found highly statistically significant associations) but didn't include the study at all in the discussion of the effect of posture. Armstrong *et al.* reported no significant associations for differences in posture ''comparing the percentage of the time spent in various postures between jobs in which there were workers with tendinitis and those in which there were no workers with tendinitis'' (Ex. 500–41–4). Dr. Moore claims that this omission by NIOSH and OSHA is an error in evaluation and that this error ''would likely have a material impact on the conclusion'' (Ex. 30–276).

OSHA has considered Dr. Moore's claim about NIOSH's evaluation of the Armstrong *et al.* study and has concluded that while Dr. Moore is correct in his claim that Armstrong *et al.* found no associations with the posture variable stated above, there is simply not enough detail in the publication to weight that study highly with regard to the posture variable. With this study group Armstrong *et al.* found a highly statistically significant odds ratio of 29.4 (p<0.001) for high force/high repetitiveness hand/wrist motion compared with a low force/low repetitiveness motion group. These groups appeared well defined and well studied with respect to force and repetitiveness, with 652 workers divided fairly evenly among the four groups increasing the statistical power to detect an effect if one exists. However, no detail is given for the posture analysis, only a short paragraph result (Ex. 500–41–4). To study this same highly force- and repetitiveness-stressed group for the effect of posture differences on hand/wrist tendinitis, (and CTS, see Silverstein *et al.*, 1987, Ex. 26–34, and comment in Ex. 32–241–4, pg.143) would appear to be quite difficult, considering the proven effect of force and repetitiveness as risk factors in this worker group. Silverstein *et al.* (1986) studying essentially the same group, discussed postures, stating:

> (W)rist postures required on a job are often determined by the height of the work station with respect to the location of the worker. * * * to test this hypothesis the job of each worker in a job would have to have been videotaped and analyzed. This was not done in this investigation. * * * Awkward postures (wrist deviation, flexion, hyperextension, and finger pinching) * * * were not controlled for in this investigation. (Ex. 26–1404).

OSHA concludes that NIOSH was correct in not considering the Armstrong *et al.* (Ex. 500–41–4) and Silverstein *et al.*1986 and 1987, (Exs. 26–1404, 26–34) study further for posture with this particular study group.

Gibson, Dunn & Crutcher also criticize OSHA's omission that the Armstrong *et al.*, study ''found no significant association between * * * vibration and [hand/wrist tendinitis] (Ex.32–241–4, pg. 140). OSHA responds that the Armstrong *et al.*, 1987, (Ex. 500–41–4) publication provided less information about vibration in the study group than it did about posture, and that apparently it was not a well studied factor in this group.

Dr. Moore also criticizes the ''NIOSH and OSHA reviews [for] inappropriately generaliz[ing] results of some studies beyond the constructs used to measure or categorize MSD risk factor [*i.e.*, force and repetitiveness]'' (Ex. 30–276, pg. 2–3), singling out Armstrong *et al.* (Ex. 500–41–4) and Silverstein *et al.*, 1987, (Ex. 26–34). OSHA has considered this comment and disagrees with Dr. Moore. Most authors define risk factors slightly differently and the NIOSH analysis had to categorize the slightly different definitions into categories. OSHA believes this categorization does not detract from either the NIOSH analysis or the ability to generalize that force and repetitiveness are etiologically related to hand/wrist tendinitis. In fact, OSHA believes that the different studies' abilities to detect significant associations using different definitions actually make the overall results more generalizable.

Gibson, Dunn & Crutcher, also criticize the Silverstein *et al.*, 1986 study of hand wrist cumulative trauma disorders (CTDs, Ex. 26–1404, and by implication Exs. 26–34 and 500–41–4) for being methodologically flawed, specifically citing recall bias and observer bias as leading to an overestimation of the associations between risk factors and health effect (Ex. 32–241–4, pg. 142–143). They also cite the study's cross-sectional design, the omission of a number of jobs from the investigation, and lack of analysis on non-biomechanical factors as serious flaws.

OSHA has considered this criticism of the methodology, but disagrees with the characterization that a cross-sectional design cannot establish causation. In another section of this preamble, OSHA discusses the value of all the studies together in forming a database to determine causality. OSHA also notes the claims of bias in this study, but agrees with the Silverstein *et al.*, 1986 study authors who found significant positive and publishable associations between hand wrist CTDs and high force-high repetitive jobs:

The findings in this investigation may also have underestimated the prevalence of hand wrist CTDs in several ways. Firstly, subject selection was limited to active workers. those away from the job with CTDs at the time of evaluation (potentially severe cases) would not have been available for study. Secondly, the one year seniority criteria for subject selection excluded those who might have had CTDs and transferred before one year as well as those with CTDs but not on the job for at least one year. The finding that hand wrist CTDs were negatively associated with age and years on the job support the argument of selection/survival bias in the study population [which would underestimate the effect] (Ex. 26–1404, pg. 784).

Gibson, Dunn & Crutcher criticize the study of shoulder pain in shipyard workers (welders and steel plate-workers) by Herberts *et al.*, 1984, (Ex. 26–51), for methodological flaws, including cross-sectional design, and the lack of demographic matching between the exposed and control groups. (Ex. 32–241–4, pg. 142). They also criticized OSHA for not recognizing what Herberts *et al.* did, have ''chronic shoulder pain is * * * common in people not necessarily active in arduous physical work.'' (Ex. 26–51, pg. 167). OSHA responds that the Agency does recognize that people other than those in HPW have shoulder pain; that recognition allows researchers, OSHA and other analysts to compare the prevalence of shoulder pain in workers doing HPW to that in workers not so engaged, in order to estimate the contribution from HPW. Herberts *et al.* also did this and concluded that ''Rotator cuff tendinitis constitutes a major problem in people with arduous occupations, *i.e.*, shipyard welders (PR=18.3%), and steel plate-workers (PR=16.2%).'' By contrast, of the 57 clerks in the comparison group only one (1.7%) reported this disorder. Of this highly statistically significant difference, Herberts *et al.*, note:

Since the clerks are on an average older than the other two groups, there would be a higher likelihood of age-induced tendinitis in this [clerks] group. However, the hypothesis is that those with a high physical workload have tendinitis to a greater extent than normal. (Ex. 26–51).

Gibson, Dunn & Crutcher also criticize OSHA's use of the Punnett *et al.*, 1991 (Ex. 26–39) study of back disorders and nonneutral trunk postures in automobile assembly workers. The study is criticized as methodologically flawed in that it is a case-control study that does not consider non-biomechanical variables (Ex. 32–241–4, pg. 140). Gibson, Dunn & Crutcher quote the authors' own cautions of the limitations of such a design, which is necessarily retrospective in recalling exposures and pre-existing conditions. OSHA acknowledges the limitations of such as design. However, OSHA considers the design, conduct, and analysis of this study quite persuasive—in terms of strength of association, temporality, and exposure-response—in the overall determination of causality of BT and LBP; see OSHA's section on back disorders in this preamble. The authors in their publication conclude:

Back disorders were associated with mild trunk flexion (OR=4.9 (p5% C.I. 1.4–17.4), severe trunk flexion (OR=5.7, 95% C.I. 1.6–20.4), and trunk twist or lateral bend (OR=5.0, 95% C.I. 1.6–21.4). the risk increased with exposure to multiple postures and increasing duration of exposure. (Ex. 26–39, pg. 337).

Gibson, Dunn & Crutcher also criticize Dr. Punnett's more recent study (1998, Ex. 26–38) of upper extremity disorders in vehicle manufacturing, as being methodologically flawed in that it is a cross-sectional design and does not include an analysis of the relative importance of psychosocial factors. OSHA has considered this comment and disagrees. Even though this study is cross-sectional, OSHA considers it well-conducted and analyzed. Using a primary exposure score relating to responses to psychophysical exposure items, Punnett found both statistically significant PRs and significant exposure-response relationships for both (1) shoulder and upper arm disorders and (2) wrist and hand disorders. The results were consistent when the analyses were done both for the symptom cases and the physical examination cases. The authors concluded that ''musculoskeletal disorders of the upper extremities were strongly associated with exposure to combined ergonomic stressors.'' (Ex. 32–241–4) Gibson, Dunn & Crutcher also criticize OSHA's use of the prospective study by Liles and Deivanayagam, 1984 (Ex. 26–33) on job severity index (JSI) for the evaluation and control of lifting injury of the back. The JSI is a function of lifting frequency of task, maximum required weight of lift, adjusted capacity of the individual, and total lifting frequency. Criticism of the study focuses on a potential bias which Gibson, Dunn & Crutcher call a ''nocebo effect'', a bias due to differential reporting of pain symptoms by the subjects, knowing that their symptoms are being monitored. OSHA responds that such a potential bias is purely speculative, and, in any case, does not explain either the increasing injury rate, the cumulative disabling injury rate or the cumulative severity rates seen with increasing JSI. (Ex. 26–33, pgs. 690–691).

Gibson, Dunn & Crutcher also criticize the study by Snook *et al.*, (1978, Ex. 26–35) on three preventive approaches to low back injury. The study is criticized as being methodologically flawed in that it is a cross-sectional study which looks solely at biomechanical risk factors, and cannot establish causation. However, Gibson, Dunn & Crutcher also quote several portions of the article that it wants OSHA to recognize: (1) that most cases of industrial back injury have no known cause, and recovery occurs before any cause is ever found, (2) some workers never suffer from low back pain regardless of their type of work, and others seem to get it in spite of what they do; and (3) ''low back injuries are usually not serious; four out of five workers suffering from low back injuries return to the job within three weeks.'' (Ex.32–241–4). OSHA responds that this Snook *et al.*, case-series study of 191 low back injuries is of limited usefulness in determining causality, but it does suggest that low back injury is associated with excessive manual handling tasks. OSHA also acknowledges the general apparent truthfulness of statement (2), by Snook *et al.*, but can find no reference for it in the article. Statement (1) of Snook *et al.*, references a 1970 published article and a 1971 editorial. There is more recent science available. Statement (3) cites one 1966 study as its reference.

Gibson, Dunn & Crutcher also criticize a study by (1992, Ex. 26–36) on low back and neck/shoulder pain in construction workers. They claim that the study is methodologically flawed in that it is cross-sectional in design, limiting its ability to show causality. At the same time they criticize OSHA for failing to discuss the study's findings of positive associations between LBP and both psychosocial factors and age, as well as the finding(s) of no significant association between sitting posture and LBP (and severe LBP). OSHA responds that with respect to sitting (>4 hours) posture and the Holmstrom *et al.* (Ex. 26–36) finding of no significant association with either LBP or severe LBP, both NIOSH (Ex. 26–1, pg. 6–47) and OSHA (see Table on back studies considered) do consider the finding of this study as ''no association'' for SWP and LBP. With respect to specific psychosocial factors being significant in this analysis, OSHA concurs. However, the discussion of psychosocial factors by Holmstrom *et al.* fails to mention whether or not the multiple regression model used also found the physical risk factors simultaneously statistically significant with these data, which would suggest that physical and psychosocial factors are independent risk factors (Ex. 26–36, pg. 667).

4. Comments on the Role of Individual and Non-Work Factors

In their posthearing testimony, Gibson, Dunn and Crutcher assert that:

> In developing its unfounded assertion that biomechanical workplace factors play a predominant role in the development of MSDs, OSHA has also ignored a great number of scientifically valid studies establishing that non-work-related factors, such as genetic predisposition, age, general health, smoking, social activities, and psychosocial factors exert a greater influence than biomechanical factors on the development of MSDs (Ex. 500–118).

Other commenters also expressed concern about the role of non-work factors in the etiology of MSDs (*e.g.*, Exs. 30–1722, 60–2037, 30–4184, 30–3077, 30–1352, 30–4130, 30–3922, 30–3114, 30–3354).

While some commenters tended to lump individual factors along with psychosocial factors, these two types of factors are clearly separate and distinct. OSHA has separated its discussion of individual factors from that of psychosocial factors, and has fully addressed comments on psychosocial factors later in this part of the Health Effects section. In this section OSHA presents it's response to comments in the record on individual factors, sometimes called ''personal'' factors. The factors that are discussed in the literature include age, susceptibility, either by genetic predisposition or medical conditions, and other factors that may be thought of as those that modify the capacity of individuals to perform work.

The above post-hearing comment (Ex. 500–18) makes two claims:

(1) that OSHA ignored an entire body of literature relevant to this rulemaking, and

(2) that had OSHA not ignored this body of literature, it would have come to an opposite conclusion than that reached by OSHA, *i.e.*, that these factors ''exert a greater influence'' presumably than biomechanical risk factors, on the development of MSDs.

OSHA, in fact, did not ignore the literature on individual factors. On the contrary, OSHA introduced the appendices to the proposed Health Effects section with a discussion of ''Individual Factors and Epidemiology of Work-Related Musculoskeletal Disorders,'' stating that:

> The multifactorial nature of MSDs requires a discussion of individual factors that have been studied to determine their association with or influence on the incidence and prevalence of work-related MSDs. These factors include age (Guo *et al.*, 1995; Biering-Sorensen *et al.*, 1983; English *et al.*, 1995; Ohlsson *et al.*, 1994); gender (Hales *et al.*, 1994; Johansson, 1994; Chiang *et al.*, 1993; Armstrong *et al.*, 1987a); anthropometry (Werner *et al.*, 1994; Nathan *et al.*, 1993; Heliovaara, 1987); physical activity (Holmstrom, Lindell, and Moritz, 1992; Baron *et al.*, 1991; Craig *et al.*, 1998); strength (Chaffin and Park, 1973; Chaffin *et al.*, 1977; Troup, Martin, and Lloyd, 1981); cigarette smoking (Finkelstein, 1995; Owen and Damron, 1984; Svensson and Andersson, 1983; Kelsey, Golden, and Mundt, 1990; Hildebrandt, 1987); and alcohol, caffeine, and vitamins (Nathan *et al.*, 1996, Keiston *et al.*, 1997). In addition, psychosocial factors have been associated with upper-extremity and back disorders (Ex. 27–1, p. I–1).

OSHA has stated elsewhere that it relied on two major reviews of the evidence for work-relatedness of MSDs available at that time, NIOSH's ''Musculoskeletal Disorders and Workplace Factors: A Critical Review of the Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back'' (Bernard, 1997; Ex. 26–1) and the National Research Council/National Academy of Sciences' ''Workshop on Work-Related Musculoskeletal Injuries: The Research Base'' (Ex. 26–37). OSHA believes that it was appropriate to place great weight on these two sources, as they are comprehensive reviews of recent peer-reviewed scientific literature conducted by highly-reputable and independent groups of scientists expert in their respective fields.

To the extent that the studies reviewed by NIOSH considered exposure to nonoccupational physical activities, such as nonoccupational VDT use, hobbies, second jobs, and household activities that might increase risk for MSDs, NIOSH included this information in its review, and acknowledges that:

> a number of factors can influence a person's response to risk factors for MSDs in the workplace and elsewhere. Among these are the following: age, gender, smoking, physical activity, strength, anthropometry.

The literature, as reviewed by NIOSH (NIOSH, 1997; Ex. 26–1): on each of these individual factors is summarized here:

Age: The prevalence of MSDs increases as people enter their working years. By the age of 35, most people have had their first episode of back pain (Guo *et al.* 1995, Ex. 26–1474; Chaffin 1979, Ex. 26–1489). Once in their working years (age 25 to 65), however, the prevalence is relatively consistent (Guo *et al.* 1995, Ex. 26–1274; Biering-Sorenson 1983, Ex. 26–843). Musculoskeletal impairments are among the most prevalent and symptomatic health problems of middle and old age. Nonetheless, age groups with the highest rates of compensable back pain and strains are the 20–24 age group for men, and the 30–34 age group for women.

NIOSH acknowledges that age-related degenerative disorders may result in decreases in musculoskeletal function, and loss of tissue strength with age may also increase the probability or severity of soft tissue damage. NIOSH also notes that:

> Another problem is that advancing age and increasing number of years on the job are usually correlated. Age is a true confounder with years of employment, so that these factors must be adjusted for when determining relationship with work. Many of the epidemiologic studies that looked at populations with a wide age variance have controlled for age by statistical methods.

However,

> Several studies found age to be an important factor associated with MSDs (Guo *et al.* 1995; Biering-Sorenson 1983; English *et al.* 1995; Ohlsson *et al.* 1994; Riihimaki *et al.* 1989a; Toomingas *et al.* 1991) others have not (Herberts *et al*, 1981; Punnett *et al.* 1985). [Ex. 26–1]

Riihimaki *et al.* (1989, Ex. 26–58) found a significant relationship between sciatica and age in machine operators, carpenters, and sedentary workers. Age was also a strong risk factor for neck and shoulder symptoms in these same groups of workers (Riihimaki *et al.* 1989, Ex. 26–58).

When a study does not find a relationship between an increased risk for MSDs and aging, lack of an observed relationship may be due to ''survivor bias.'' If workers who have health problems leave their jobs, or change jobs to one with less exposure, the remaining population includes only those workers whose health has not been adversely affected at their jobs. As an example, in a study of female plastics assembly workers, Ohlsson *et al.* (1989, Ex. 26–1290) reported that the degree of increase in the odds of neck and shoulder pain with the duration of employment depended on the age of the worker. For the younger subjects, the odds increased significantly as the duration of employment increased, but for the older ones no statistical change was found with length of employment. The older women who had been employed for shorter periods of time had more reported symptoms than the younger ones, while older workers with longer employment times reported fewer symptoms than younger workers. Ohlsson *et al.* (1989, Ex. 26–1290) interviewed 76 former assembly workers and found that 26% reported pain as the cause of leaving work. This finding supports the likely role of a survivor bias in this study, the effect of which is to underestimate the true risk of developing MSDs, in this case in the older workers.

Some studies report observing an increased risk for MSDs with age, others do not. Where the effects of age have been controlled for in studies, thus eliminating the influence of ''age'' in the equation, the physical risk factors discussed here have been consistently shown to be associated with the development of MSDs in exposed populations. This means that, regardless of whether or not age plays a role in the development of a particular MSD in a particular population, the influence of physical risk factors is independent.

Gender Some studies have found a higher prevalence of some MSDs in women (Bernard *et al.* 1994, Ex. 26–842; Hales *et al.* 1994, Ex. 26–131; Johansson 1994, Ex. 26–1331; Chiang *et al.* 1993, Ex. 26–1117). A male-to-female ratio of 1:3 was described for carpal tunnel syndrome (CTS) in a population study in which occupation was not evaluated (Stevens *et al.* 1988, Ex. 26–1009). However, in the Silverstein *et al.* (1985, Ex. 26–1173) study of CTS among industrial workers, no gender difference could be seen after controlling for work exposure. Franklin *et al.* (1991, Ex. 26–948) found no gender difference in workers' compensation claims for CTS. Burt, Hornung, and Fine (1990, Ex. 26–698) found no gender difference in reporting of neck or upper-extremity MSD symptoms among newspaper employees using video display terminals (VDTs). Nathan *et al.* (1988, Ex. 26–990; 1992, Ex. 26–988) found no gender differences for CTS. In contrast, Hagberg and Wegman (1987, Ex. 26–32) reported that neck and shoulder muscular pain is more common among females than males, both in the general population and among industrial workers.

Whether the gender difference seen with some MSDs is due to physiological differences or differences in exposure is unclear. One laboratory study, Lindman *et al.* (1991, Ex. 26–976), found that women have more type I muscle fibers in the trapezius muscle than men, and have hypothesized that myofascial pain originates in these type I muscle fibers. Ulin *et al.* (1993, Ex. 26–223) noted that significant gender differences in work posture were related to stature and concluded that the lack of workplace accommodation to the range of workers' height and reach may, in part, account for the apparent gender differences.

The fact that more women are employed in hand-intensive jobs and industries may account for the greater number of reported work-related MSDs among women. Bystrom *et al.* (1995, Ex. 26–897) reported that men were more likely to have de Quervain's disease than women; they attributed this to more frequent use of hand tools.

The reporting bias may exist because women may be more likely to report pain and seek medical treatment than men (Armstrong *et al.*, 1993; Hales *et al.*, 1994). Some studies have reported that workplace risk factors account for increased prevalence of MSDs among women more than personal factors (*e.g.*, Armstrong *et al.* 1987, Ex. 26–1110; McCormack *et al.* 1990, Ex. 26–1334). In a recent evaluation of Ontario workers' compensation claims for repetitive strain injury (RSI), Asbury *et al.* (1995, Ex. 26–250) reported a relative risk (RR) for female to male claims ranging from 1.3 to 1.6 across industries. Within five different broad occupational categories, females were approximately 2 to 5 times as likely to have a lost-time RSI claim. No information on gender differences in hand-intensive jobs was reported. Many researchers have noted that men and women tend to be employed in different jobs.

Smoking. In the Viikari-Juntura *et al.* (1994, Ex. 26–873) prospective study of machine operators, carpenters, and office workers, current smoking (OR: 1.9; 95% CI: 1.0–3.5), was among the predictors for change from ''no neck trouble'' to ''severe neck trouble.'' In a study of Finnish adults aged 30 to 64 (Makela *et al.* 1991, Ex. 26–980), neck pain was found to be significantly associated with current smoking (OR: 1.3; 95% CI: 1.0–1.61) when the logistic model was adjusted for age and gender. However, when the model included mental and physical stress at work, obesity, and parity, then smoking (OR: 1.25; 95% CI: 0.99–1.57) was no longer statistically significant (Makela *et al.* 1991, Ex. 26–980). With univariate analysis, Holmstrom (1992, Ex. 26–36) found a prevalence rate ratio (PRR) of 1.2 (95% CI: 1.1–1.3) for neck/shoulder trouble in ''current'' smokers vs. people who ''never'' smoked. But using multiple logistic regression, when age, individual, and employment factors were in the model, only ''never smoked'' contributed significantly to neck/shoulder trouble.

While investigating reasons for higher compensation claims for CTS in certain employee groups, Nathan *et al.* (1996, Ex. 26–882) evaluated the effects of tobacco, caffeine, and alcohol on the prevalence of median entrapment neuropathy at the wrist, CTS symptoms, and CTS confirmed by nerve conduction studies among industrial workers (nonclaimants and working patients referred for upper-extremity symptoms) who volunteered for the study. Nathan *et al.* (1996, Ex. 26–882) stated that greater use of tobacco combined with greater consumption of caffeinated beverages and alcohol abuse was associated with more median nerve slowing, more specific hand/wrist symptoms, and more electrophysiologically confirmed CTS. However, the effects explained only a small portion of the total risk.

Toomingas *et al.* (1991, Ex. 26–1019) found no associations between multiple health outcomes (including tension neck syndrome, rotator cuff tendinitis, CTS, or problems in the neck/scapula or shoulder/upper arm) and nicotine habits among platers, assemblers, and white collar workers. In a case/referent study, Wieslander *et al.* (1989, Ex. 26–1027) found that smoking or using snuff was not related to CTS among men operated on for CTS.

Several papers have presented evidence that a positive smoking history is associated with low-back pain, sciatica, or intervertebral herniated disc (Finkelstein 1995, Ex. 26–369; Frymoyer, Pope, and Clements 1983, Ex. 26–950; Svensson *et al.* 1983, Ex. 26–1158; Kelsey *et al.* 1984, Ex. 26–152); whereas other papers have found a negative relationship (Kelsey, Golden, and Mundt 1990, Ex. 26–52; Riihimaki *et al.* 1989, Ex. 26–997). Boshuizen *et al.* (1993, Ex. 26–81) found a relationship between smoking and back pain only in those occupations that required physical exertion. In their study, smoking was more clearly related to pain in the extremities than to pain in the neck or the back. Deyo and Bass (1989, Ex. 26–105) observed that the prevalence of back pain increased with the number of pack-years of cigarette smoking and with the heaviest smoking level. Heliovaara *et al.* (1991, Ex. 26–959) only observed a relationship in men and women older than 50 years. Two studies did not find a relationship between sciatica and smoking among concrete reinforcement workers and house painters (Heliovaara *et al.* 1991, Ex. 26–959; Riihimaki *et al.* 1989, Ex. 26–997).

Several explanations for the relationship with smoking have been postulated. One hypothesis is that back pain is caused by coughing from smoking. Coughing increases the abdominal pressure and intradiscal pressure and puts strain on the spine. A few studies have observed this relationship (Deyo and Bass 1989, Ex. 26–105; Frymoyer *et al.* 1980, Ex. 26–707; Troup *et al.* 1987, Ex. 26–1307). The other mechanisms proposed include nicotine-induced diminished blood flow to vulnerable tissues (Frymoyer, Pope, and Clements 1983, Ex. 26–950), and smoking-induced diminished mineral content of bone causing microfractures (Svensson *et al.* 1983, Ex. 26–1158). Similar associations with diminished blood flow to vulnerable tissues have been found between smoking and Raynaud's disease.

Strength. Some epidemiologic support exists for the relationship between back injury and a mismatch of physical strength and job tasks. Chaffin and Park (1973, Ex. 26–1115) found a sharp increase in back injury rates in subjects performing jobs requiring strength that was greater than or equal to their isometric strength-test values. The risk was 3 times greater in the weaker subjects. In a second longitudinal study, Chaffin *et al.* (1977, Ex. 26–1111) evaluated the risk of back injuries and strength and found the risk to be 3 times greater in the subjects without lower static strength. Keyserling, Herrin, and Chaffin (1980, Ex. 26–970) strength-tested subjects, biomechanically analyzed jobs, and assigned subjects to either stressed or non-stressed jobs. Following medical records for a year, they found that job matching based on strength criteria appeared to be beneficial. In another prospective study, Troup, Martin, and Lloyd (1981, Ex. 26–1456) found that reduced strength of back flexor muscles was a consistent predictor of recurrent or persistent back pain, but this association was not found for first-time occurrence of back pain.

Other studies have not found the same relationship with physical strength. Two prospective studies of low-back pain reports (or claims) of large populations of blue collar workers (Battie *et al.* 1989, Ex. 26–72; Leino, Aro, and Hasan 1987, Ex. 26–1142) failed to demonstrate that stronger (defined by isometric lifting strength) workers are at lower risk for low-back pain claims or episodes. One study followed workers for 10 years after strength testing and the other followed workers for a few years. Neither of these studies included precise measurement of exposure level for each worker, so the authors could not estimate the degree of mismatch between workers' strength and task demands. Battie compared workers with back pain with other workers on the same job (by isometric strength testing) and did not find that workers with back pain were weaker. In two studies of nurses (Videman *et al.* 1989, Ex. 26–1155; Mostardi *et al.* 1992, Ex. 26–986), lifting strength was not a reliable predictor of back pain.

When examined together, these studies reveal the following: the studies that found a significant relationship between strength and back pain used more thorough job assessment analysis and focused on manual lifting jobs. However, these studies only followed workers for periods of 1 year, and whether this same relationship would hold over a much longer working period remains unclear. The studies that did not find a relationship, although they followed workers for longer periods of time, did not include precise measurements of exposure level for each worker, so they could not assess the strength capabilities that were important in the jobs.

Anthropometry. Weight, height, body mass index (BMI) (a ratio of weight to height squared), and obesity have all been identified in studies as potential risk factors for certain MSDs, especially CTS and lumbar disc herniation. Obesity seems to play a small but significant role in the occurrence of CTS (see Section B.4.a). Anthropometric data are conflicting, but in general indicate that there is no strong correlation between stature, body weight, body build, and low-back pain.

Few studies examining anthropometric risk factors in relationship to CTS have been occupational epidemiologic studies; most have used hospital-based populations that may differ substantially from working populations. Nathan *et al.* (1988, Ex. 26–990; 1992, Ex. 26–989; 1994, Ex. 26–517) have published several papers about a single industrial population and have reported an association between CTS and obesity; however, the methods employed in their studies have been questioned in a number of subsequent publications (Gerr and Letz 1992, Ex. 26–384; Mackinnon *et al.* 1997, Ex. 26–1309; Stock 1991, Ex. 26–1010; Werner *et al.* 1994, Ex. 26–237). Several investigators have reported that their industrial study subjects with CTS were shorter and heavier than the general population (Cannon *et al.* 1981, Ex. 26–1212; Dieck and Kelsey 1985, Ex. 26–944; Falck and Aarnio 1983, Ex. 26–1122; Nathan *et al.* 1992, Ex. 26–989; Werner *et al.* 1994, Ex. 26–237; Wieslander *et al.* 1989, Ex. 26–1027).

Werner *et al.* (1994, Ex. 26–237) studied a clinical population requiring electrodiagnostic evaluation of the right upper extremity, patients classified as obese (BMI > 29) were 2.5 times more likely than slender patients (BMI < 20) to be diagnosed with CTS. These researchers developed a multiple linear-regression CTS model (with the difference between median and ulnar sensory latencies as the dependent variable). The regression highlighted BMI as the most influential variable, but still only accounted for 5% of the variance in the model. In Nathan's (1994, Ex. 26–517) logistic model, BMI accounted for 8.6% of the total risk; however, this analysis used both hands from each study subject as separate observations, although they are not independent of each other. Falck and Aarnio (1983, Ex. 26–1122) found no difference in BMI among 17 butchers with (53%) and without (47%) CTS. Vessey, Villard-Mackintosh, and Yeates (1990, Ex. 26–229) found that the risk for CTS among obese women was double that for slender women.

Nordstrom *et al.* (1997, Ex. 26–900), in a study of risk factors for CTS in a general population, concluded that BMI is one factor that seems to have a causal relation to CTS. These researchers found that for each increase of one unit of BMI, about 6 pounds for the average-sized adult, risk of CTS increases by 8%. Werner *et al.* (1997, Ex. 26–718), in a study at five different worksites (four industrial, one clerical), concluded that obesity (BMI > 29), industrial work, and age were independent risk factors for median mononeuropathies. Their study, which did not define specific work-related exposures, showed no significant interaction between work activity and obesity. However, the authors caution interpretation of the data and urge more investigation. It has been suggested that relationship of CTS with BMI involves increased fatty tissue within the carpal canal or increased hydrostatic pressure throughout the carpal canal in obese persons compared with slender persons (Werner 1994, Ex. 26–237).

Two other anthropometric risk factors, carpal tunnel size and wrist size, have been suggested as risk factors for CTS; however, some studies have linked both small and large canal areas to CTS (Bleecker *et al.* 1985, Ex. 26–934; Winn and Habes 1990, Ex. 26–1029).

Schierhout *et al.* (1995, Ex. 26–403) found that short stature was significantly associated with pain in the neck and shoulder but not in the forearm, hand and wrist, or back, among workers in 11 factories. Height was not a factor for neck, shoulder, or hand and wrist MSDs among newspaper employees (Bernard *et al.* 1994, Ex. 26–842). Kvarnstrom (1983, Ex. 26–1201) found no relationship between neck/shoulder MSDs and body height in a

Swedish engineering company with more than 11,000 workers.

Examples exist where biomechanical or physical risk factors have been labeled as individual factors. During the hearing for this rulemaking, Dr. Niklas Krause mentioned two of these examples, the first refers to people in the military who drive tanks, and found that tall people have more back pain than short people. A very logical explanation for the observation of increased back pain was provided by Dr. Krause:

Well, if you have ever entered a tank, you know that it is not constructed for very tall people. There is not much room in there. [Tr. 1378]

And a second example, also provided by Dr. Krause:

And we have actually found in our bus drivers, too, and we measured. We had their height and their weight. We found that an ergonomic evaluation of the bus fleet showed that the buses that are running in San Francisco were constructed for people—that is what the ergonomics Professor Thompson from Sanford found out when he looked at them—were constructed for people in the upper 10 percent of the North American population.

You can imagine if you hire small people, Asians and women for example, into that work force and put them on this bus that the fit is bad. And actually, what we see is that over the years, the percentage of small drivers drops on that work force rapidly.

When they enter, when people take the job, there is about 6 percent of drivers who are small, defined as * * * the lower half of the population. * * * After one to five years, only 2.9 percent of these small people are in the workforce. After six to ten years, only 1.3 percent. And after eleven to fifteen years, only 0.4 percent. This is a statistically significant trend. And it clearly shows you that people based on their smallness and misfit probably had to leave the occupation. [Tr. 1378–1380]

When used to determine whether a correlation exists between stature, body weight, body build and low back pain, anthropometric data are conflicting, but in general indicate that there is no strong correlation. Obesity seems to play a small but significant role in the occurrence of CTS.

Genetics. Another type of factor that affects an individual's capacity is genetic make-up. While the term ''genetic susceptibility'' is often heard; in reality both the amount of genetic information involved in the response and the variability of possible responses are vast and for the most part, not yet understood. The little bit of work done in this area was done by Videman, and is covered in a brief discussion in the section on the low back.

A worker's ability to respond to work factors may be modified by his or her own capacity. The capacity to perform work varies with gender and age, among workers, and for any individual over time. The relationship between biomechanical risk factors, both inside and outside the workplace, these individual as well as other factors and the resulting risk of injury to the worker is complex, but not unique to this OSHA standard.

For each of the ''individual factors'' discussed here, some studies report observing an increased risk for MSDs, others do not. What they have in common, is their ability to effect the capacity of individuals independently from biomechanical risk factors. In other words, in those studies where the effects of age, gender, smoking, etc. have been controlled for, the physical risk factors discussed here have been consistently shown to be associated with the development of MSDs in exposed populations. This means that, regardless of whether or not age plays a role in the development of a particular MSD in a particular population, the influence of biomechanical risk factors is independent from other associated factors. Furthermore, it has been demonstrated repeatedly, that reducing these biomechanical factors in the workplace results in reductions in the incidence of work-related MSDs.

The AFL/CIO found that the record provides some additional evidence that individuals may vary in their susceptibility to developing certain work-related MSDs, such as carpal tunnel syndrome, based on individual factors including age, body weight and gender (Ex. 26–1, Ex. 26–37, Ex. 500–71–93). They also found that other evidence in the record indicates that for back and neck pain or disorders, for example, no association with age, gender, height or weight has been established (Ex. 500–71–24, Tr. 1332).

The AFL/CIO point out that:

Obviously the underlying principle of ergonomics is to fit the job to the worker, and so personal physical characteristics do come into play when evaluating certain MSD risk factors. A worker who is 5′2″ may have a much longer reach to an assembly line than her 6′0″ co-worker. But other than as relevant to evaluating exposure to known risk factors, personal characteristics and differences in susceptibility are irrelevant to this rulemaking. This regulation, and all other OSHA standards, are designed to regulate risks that are found in the workplace that may result in the development of an adverse outcome (MSDs) in workers who are exposed to risk factors which have been demonstrated to cause MSDs. The ergonomics regulation is consistent with OSHA's responsibility to regulate hazards which are present in the workplace. To shift the focus toward personal characteristics, as some industry opponents have argued, only clouds this issue by blaming the victims. [Ex. 500–218]

On this same subject, Dr. Frederick Gerr, Emory University (Tr. 1525–26):

Some will argue that personal factors, such as gender and body weight, are the cause of these disorders among American workers, rather than ergonomics hazards in the workplace. The fact that personal characteristics can increase the risk for these disorders in no way undermines the evidence that work has been clearly shown to increase their risk as well.

The blame-the-victim approach to these disorders is both scientifically and ethically bankrupt. Virtually all occupational illnesses, including asthma, cancer, skin disease, peripheral and central nervous system disorders, and many others, have causes that extend outside of the workplace. This fact does not lessen the added burden of disease that occupational exposures produce.

Non-Work Leisure Activities

The commenters (*e.g.,* Exs. 30–2493, 31–324, 30–3368, 30–605, 30–3783, Tr. 5073) also raise the issue of the relationship of ''non-work'' to the development of MSDs. By this, OSHA assumes the reference is to those activities such as nonoccupational VDT use, hobbies, second jobs, and household activities, activities that may result in additional exposure to biomechanical factors similar to that the individual is experiencing at the workplace. If this assumption is correct, then ''non-work'' may actually refer to exposure to the same types of physical/biomechanical factors that may be additive to similar workplace exposure.

And, while it is true that the physical/biomechanical risk factors which increase the risk of MSDs at work can also be found outside of work and may lead to MSDs (Ex. 500–71–93). However, according to Dr. Nicholas Warren from the University of Connecticut (Tr. 1077–78):

It is very seldom the case that home risk factors are encountered with the same intensity or the same duration as they are encountered in the workplace.

On the same subject , the AFL/CIO (Ex. 500–218) notes:

Opponents of the standard, while arguing that there is no evidence that physical factors at work cause MSDs, also simultaneously argue that it is non-work leisure physical activities which cause MSDs and that an OSHA standard cannot regulate adverse health conditions and exposures to risk factors which are partially, primarily or exclusively the result of non-work activities (Ex. 32–241–4).

For most musculoskeletal disorder cases, ''workplace factors are the predominant risk and it is upon these risks, obviously, that the OSHA proposed rule focuses (Tr.1079). Other evidence in the record confirms that there is little or no impact on the development of MSDs related to the back from non-work participation in sports, exercise, and leisure time physical activity (Ex. 500–71–24, Ex. 500–71–32, Ex. 502–510).

The AFL/CIO also states:

Thus the record evidence suggests that the non-work exposures to risk factors rarely, if ever, occur at the same frequency, duration or magnitude as workplace exposures. Even where workers are exposed to non-work risk factors off the job, it is important to point out that this standard is designed only to decrease exposures to biomechanic risk factors occurring at the workplace. An analogy may be drawn to the risks of incurring hearing loss from excessive exposure to noise. Exposure to noise at levels and durations which can cause or contribute to noise-induced hearing loss can and do occur both at the workplace as well as in non-work situations. While these work and non-work exposures and risks of developing hearing loss exist, OSHA's noise standard is confined exclusively to addressing excessive noise exposures in the workplace. [Ex. 500–218]

And from Dr. Nicholas Warren, University of Connecticut (Tr. 1078–79):

When I work with an individual with, for instance, carpal tunnel syndrome, carrying out forceful, repetitive tasks over most of a nominal 40 hour work week and then often into another 10 hours of voluntary overtime, it's painful to hear an insurer gleefully inform me that this person bowls in a league on Saturday night. It is equally painful to hear the worker blame him or herself by saying, ''That's probably because I knit,'' when, in fact, a clear objective assessment of the workplace risk factors reveals that these are much more important in the etiology of his or her disease.

OSHA concludes that, in general, each individual's capacity is affected differently by many factors including some of those presented here: age, gender, smoking, physical activity, strength, anthropometry, genetic factors and activities outside the workplace. This is also true in the more specific case of the development of work-related MSDs. However, it is important to remember that exposure to biomechanical factors in the workplace is independent of those factors that each individual brings to the workplace, *i.e.,* when the influence of individual factors is controlled for in studies, effects due to exposure to biomechanical factors are still observed . It is also true that in the vast majority of cases, where exposure to biomechanical exposures is high, the effects due to biomechanical exposures are far greater than those associated with these types of individual factors.

5. Role of Psychosocial Factors in the Etiology of MSDs

The role of psychosocial factors in the etiology of MSDs was a subject of much debate during the rulemaking. Many participants, in particular the Chamber of Commerce (Ex. 500–188), Gibson, Dunn & Crutcher (Exs. 32–241–4, 500–197), and several research and medical scientists who testified on behalf of UPS (Exs. 32–241–3–2, 32–241–3–3, 32–241–3–5, 32–241–3–8, 32–241–3-12), criticized the proposed rule for its failure to take into account the contribution of psychosocial risk factors to MSD causation and exacerbation, believing that psychosocial factors play a significantly greater role than do biomechanical risk factors in the development of MSDs and the disabilities associated with them.

Much of the scientific literature that addresses the etiology of MSDs has examined aspects of the social and psychological environment that may have a causal or moderating role in MSD development and exacerbation. In this part of the Health Effects section, OSHA first discusses what is meant in the literature by the term ''psychosocial factors.'' Following this discussion, OSHA summarizes the expert testimony of witnesses and rulemaking participants who have evaluated the body of psychosocial literature as it relates to the work-related risk of MSDs. Finally, OSHA presents its own literature review, summarizing specific studies contained in the rulemaking docket that have examined and compared the roles of biomechanical and psychosocial factors in the etiology of MSDs, and summarizes several literature reviews that have been published on this topic.

Definition of Psychosocial Factors

The study of psychosocial factors as it applies to the study of work-related MSDs is surrounded by a measure of confusion because there are several very different definitions of ''psychosocial'' used in common and in technical parlance. Lack of clarity and consensus in defining psychosocial factors was addressed by some researchers at the public hearing (Tr. 867–868, 1306, 17443). There are three general concepts of psychosocial factors that apply. Most researchers who have examined the role of psychosocial factors in the etiology of MSDs have emphasized the external aspects of the psychological and social work environment that cause the worker to experience ''stress'', a condition of chronic or prolonged arousal of the human ''flight or fight'' mechanisms that has been linked to a wide variety of negative health outcomes, including MSDs. The primary aspects of the psychosocial work environment include level of psychological job demands, level of worker control over the job process, and level of social support received from co-workers, supervisors and the organization. Some researchers focus on additional conceptualizations of psychosocial exposures, including job security, monotony, and job satisfaction (for example, Krause, 1998, Ex. 38–242, Bigos, 1991b Ex. 26–1242). Psychosocial factors reflecting these external aspects of the work environment have been the subject of investigation in nearly all of the studies and literature reviews discussed in this section.

As is the case with biomechanical risk factors, proposed exposure-outcome relationships for psychosocial factors are multifactoral, *i.e.,* several of these factors may be in play in any given situation, and may combine and interact in complex ways that are difficult to study and understand (Bongers *et al.,* 1993, Ex. 26–1292, Bernard, 1997, Ex. 26–1 Warren *et al.,* 2000a, b, Exs. 38–75, 38–73). It is unlikely that these psychosocial workplace risk factors occur and act in isolation of biomechanical risk factors (Tr. 868–869, 1264, 5942–5943, NIOSH 1997 (Ex. 26–1), NAS 1999 (Ex. 26–37)).

A growing body of literature also identifies aspects of organizational structure, technology, policy, and culture as potential contributors to occupational disease and characterizes them as organizational risk factors (Shannon, *et al.,* 1996, Ex. 26–1368, 1997, Ex. 26–1369, Warren, 1997, Ex. 38–72, Warren *et al.,* 2000a, Ex. 38–75). Organizational risk factors are proposed as the underlying bases of work design in the company; through their effect on work organization, they determine levels of both psychosocial and biomechanical risk factors experienced by employees. It is this common set of roots that results in the strong co-variation of psychosocial and biomechanical risk factors noted below. The second concept of psychosocial factors that has been used in the literature relates to the internal characteristics of the worker's psychological makeup that affect how he/she appraises, processes and reacts to external biomechanical and psychosocial factors, and thus moderates how these external factors are experienced internally. There are studies demonstrating that individual psychological factors can increase susceptibility to MSD development and affect MSD recognition and reporting (Linton, 2000, Ex. 502–413, NAS, 1999 Ex. 26–37). Emerging research sugg influence care-seeking and disability than initial onset of disease (Linton, 1992, 2000, Ex. 502–413 ests that internal psychological factors more strongly, Waddell & Burton, 2000, Ex. DC–151–A). Some researchers and physicians combine internal and external psychological factors in their definition of psychosocial factors; for example, Dr. Raymond Bellamy, an orthopedic surgeon testifying on behalf of UPS *et al.,* included such factors as dislike of job, recent poor performance evaluation, depression and anxiety, hypochondriasis, and desire for narcotics in his description of psychosocial factors (Ex. 32–241–3–3). Dr. Arthur Barsky, also testifying on behalf of UPS *et al.,* stated that psychosocial factors (his use of the term conflates external factors and internal psychological factors) ''exacerbate, perpetuate, and maintain these [musculoskeletal] symptoms and amplify the disability they engender'' (post-testimony comments, p.1, Ex. 500–118–1). Thus, it is not always clear in the literature or in the testimony contained in the record when the term ''psychosocial factors'' is being used to refer to external psychological or social workplace factors, internal psychological makeup of the worker, or both.

The third concept of psychosocial factors relates to aspects of the legal, insurance and medical environment that influence a worker's tendency to identify a particular constellation of symptoms as a disease. At its most extreme, this definition is used to claim that workers make up and fake disease, for ''secondary gain''. A broader interpretation is the argument that these aspects of legal and medical recognition and possible financial gain may subtly, even unconsciously influence a worker's honest identification of symptoms as a disease and predisposition to report it.

Although individual psychological factors or medical/legal factors may affect MSD perception and reporting to a degree, it is unlikely that they play a major causal role in the etiology of MSDs. This is because the increased prevalence and incidence of MSDs seen among workers who are highly exposed to biomechanical risk factors cannot be adequately explained primarily by psychological factors given the present state of the evidence. As the discussion in this Health Effects section has demonstrated, the epidemiological, laboratory, psychophysical, and intervention literature demonstrating quantifiable links between biomechanical exposures and MSD outcomes is overwhelming. Many studies have demonstrated substantial differences in MSD incidence and prevalence between companies and industry sectors that correlate strongly with the presence of physical risk factors (for example, Franklin *et al.,* 1991, Ex. 26–948, NAS, 1999, Ex. 26–37, see also the Risk Assessment section (Section VI) of this preamble). Thus, it is highly unlikely that an individual with psychological tendencies towards negative reactions at work or tendencies to seek out care-givers would preferentially select themselves into physically demanding jobs. It is also impossible to imagine how prospects for secondary gain would be differentially distributed into occupations or industry sectors that involve highly physical work.

Consequently, this part of the Health Effects section focuses on the large number of studies that have simultaneously examined the roles of biomechanical risk factors along with psychosocial factors that relate to external aspects of the psychological and social work environment. These studies generally represent the most recent studies of work-related MSDs in the literature.

Discussion of Testimony on the Psychosocial Literature

Based on these studies, the Chamber of Commerce (Ex. 500–188) and Gibson, Dunn & Crutcher representing UPS, Anheuser-Busch, the National Coalition on Ergonomics, and others (*e.g.*, Exs. 32–231–4, 500–197, 32,435, 30–3346, Tr. 3655) were critical of OSHA emphasizing the role of biomechanical risk factors over psychosocial factors in its scientific literature review. For example, in their post-hearing brief, Gibson, Dunn & Crutcher commented that

> The science has shown that where psychosocial factors in particular are considered, they generally overwhelm the weak and inconsistent associations between biomechanical exposures and the reporting of MSDs. Yet the * * * [A]gency dismissed the validity of psychosocial factors in cavalier fashion * * * [Ex. 500–197, p. I–33]

Similarly, the Chamber of Commerce stated that ''The Agency has egregiously ignored each and every one of these indisputably relevant factors * * *'' (Ex. 500–188), and explained the necessity for OSHA to evaluate the role of psychosocial factors in the workplace:

> * * * [D]etermining why individuals feel the need to report and/or to seek medical care for such complaints is a complex problem involving not only the physical exposures, but psychosocial factors such as job satisfaction, ability to control the work environment, interpersonal relationships at work, and the like * * * And, in the vast majority of studies that have assessed whether biomechanical workplace factors and psychosocial factors cause musculoskeletal complaints, psychosocial factors are just as significant, or more significant than, biomechanical factors. (Ex. 500–188, p. 41)

In addition, several research and medical scientists testifying on behalf of UPS *et al.* stated in written or oral comment that the scientific literature strongly supported that psychosocial factors play a dominant role in the etiology of MSDs (Exs. 32–241–3–2,32–241–3–3, 32–241–3–5, 32–241-3–8, 32–241–3–12). For example,

Dr. Alf Nachemson concluded a review of the literature by stating that

> * * * [t]he research indicates that psychosocial factors are not simply an overlay but rather an integral part of the pain disability process that includes emotional, cognitive and behavioral aspects * * * [T]here was strong evidence of the highest level that psychosocial variables generally have more impact than biomedical or biomechanical factors on pain disability.'' (Ex. 32–241–3–12, p. 13)

Dr. Norton Hadler stated in written comment that

> Associations between disabling regional musculoskeletal symptoms and psychosocial variables overwhelm and explain away any and all associations with biomechanical exposures. (Ex.32–241–3–8, p. 18)

Taking a more moderate interpretation of the literature, Dr. Arthur Barsky agreed that MSDs are not entirely a psychosocial problem; however, he felt that ignoring them in designing intervention programs can make the problem worse (Ex. 500–118–1, p. 1). At the public hearing, he explained that

> * * * [workers'] symptoms really are better understood as a social communication, as a kind of non-verbal way of responding to difficulties in the workplace—job dissatisfaction, role conflicts, insecurity around the job, a whole variety of psychosocial work conditions—and to hear these as a biomedical complaint is to totally miss the point * * * What really concerns me, is * * * [that complaints of MSD symptoms are] a kind of social communication * * * a metaphor for life stress, for psychosocial distress * * * and the response that too often is made to a symptom like that, is [an inappropriate] referral to orthopedics. Tr. 17043–17044]

Dr. Barsky illustrated his point with an example of a widowed mother of two worked two jobs and visited the emergency room of a hospital complaining of tired feet [Tr. 17043–17044], and viewed the proposed ergonomics standard as an inappropriate response to such an ''interpersonal communication'' (Tr. 17044).

Other scientists testifying on behalf of the UPS echoed the conclusions reached by Dr. Nachemson in his literature review and Dr. Bigos, who referred to his groups Boeing study (Ex. 26–1241, 26–1242,26–1393) in contending that low back pain (LBP) is primarily a psychosocial phenomenon (Exs. 32–241–3–2, 32–241–3–5). Other commenters also remarked on the importance of psychosocial factors in the development of MSDs (*e.g.,* Exs. 32–435, 30–3346, 30–3086, 30–536, 30–4046, 30–1070, Tr. 3655).

Many of OSHA's scientific witnesses disputed these interpretations of the psychosocial literature, stating that the literature is not in conflict with the causal relationship that has been demonstrated between exposure to biomechanical risk factors and development of MSDs, and that psychosocial factors had generally less of an influence than biomechanical factors in these studies (Tr. 842, 874, 1087, 1206, 1364, 1537–1540). For example, Dr. Thomas Armstrong testified that

> * * * [M]ore than a critical mass of epidemiological literature shows that biomechanical factors are important predictors of the occurrence of musculoskeletal disorders and the elevated risk of harm.
>
> In studies where we have included both psychosocial and physical risk factors, the physical factors come out as the strongest predictor. [Tr. 842]

Dr. Laura Punnett testified that ''* * * the impact of physical exposures at work is beyond that explained by demographics, medical history, psychosocial features of the work environment or other factors'' (Tr. 874). Similarly, Dr. Nicholas Warren testified that in studies that have measured both biomechanical and psychosocial factors

> * * * we almost always find that both contributed. If you control for psychosocial risk factors[,] which well-designed studies allow you to do, you'll find a strong contribution from biomechanical risk factors and that it generally, not in all workplaces, but in most workplaces, is a larger effect than that of the psychosocial risk factors. [Tr. 1087]

When asked whether he would agree with Gibson, Dunn & Crutcher's statement in their pre-hearing submission that ''a majority of medical experts who study the causes of MSDs believe most chronic workplace pain is caused by psychosocial issues'' (Ex. 32–241–4, p. 36), both Dr. Bradley Evanoff and Dr. Fred Gerr disagreed. Dr. Evanoff believed the opposite was true, that ''the majority of people studying work-related musculoskeletal disorders * * * feel that physical exposures are a very strong risk factor'' Tr. 1358). Dr. Gerr stated that he was ''aware of absolutely no basis in the medical or scientific literature that [would] substantiate that statement'' (Tr. 1538). Both also strongly disagreed (Tr. 1538–1539) with Dr. Hadler's statement in his written testimony that psychosocial factors ''overwhelm and explain away any and all associations with biomechanical factors'' (Ex.32–241–3–8, p. 18).

Several other researchers and medical scientists appearing at the hearing on their own behalf disagreed with the UPS witnesses assessments that psychosocial factors predominate in the etiology of MSDs (Tr. 2838, 2840, 7857–7858, 9504, 9880). Dr. George Piligian of the Mt. Sinai Center for Occupational and Environmental Medicine, when asked whether it was appropriate for OSHA to emphasize the role of biomechanical factors in its proposed rule given the evidence on psychosocial factors, responded with an analogy:

> * * * [Suppose] a person is thirsty and has come from the desert, and if you have only half a glass of water to offer that person[.] * * * Someone argued and said * * * I don't think we should give this person that half a glass of water until it's full * * * I would venture to say that the person who is thirsty would probably beg you to give them that half a glass of water, then, go back and fill it * * * .
>
> We are doing what we can with the knowledge we have rather than using the argument, which I find actually counterintuitive * * * that we must have every single thing that we know of in place before we proceed. [Tr. 7857–7859]

Some of OSHA's expert witnesses who are actively engaged in research on work-related MSDs testified that an important finding from the more recent literature is that biomechanical risk factors have been shown to be associated with MSDs independently from psychosocial factors (Tr. 1327–1328, 1331–1332, 1335, 1343, 1365, 1412). Dr. Niklas Krause, in testifying on his own prospective study of public transit operators and low back disorders (Ex. 500–87–2), stated that

> The main result * * * is that both biomechanical and psychosocial job factors were independently associated with spinal disorders * * * [I]ndependent positive dose response relationships were also found for ergonomic problems * * * I conclude from this new high quality evidence [referring to the Loisel *et al.*(Ex. 38–28) randomized trial study] and the literature that has been already collated by OSHA [in its preamble to the proposed rule and Health Effects Appendices (Ex. 27–1) that high-quality epidemiological studies confirm that physical work place factors cause MSDs independently from individual worker characteristics and psychosocial job factors * * * [Tr. 1331–1335].

Dr. John Frank testified that the Kerr *et al.* case-control study (Ex. 38–82) in which he participated also found an association between MSDs and exposure to biomechanical risk factors independent from psychosocial factors. When asked about the significance of that finding, Dr. Frank responded

> The importance particularly for the proposed standard or any public health efforts to reduce biomechanical hazards at work is that[,] * * * acting on biomechanical risk factors will bring risk reductions according to our understanding of the multifactorial causal process even if we are unable * * * at the present time to conclusively act to reduce psychosocial factors * * * [Tr. 1365–1366]

Dr. Frank also drew a parallel with successful efforts to control cholesterol blood levels to reduce heart disease incidence, despite ''two dozen or more'' other risk factors that contribute to heart disease because high cholesterol levels are independently associated with an increased risk of heart disease (Tr. 1365–1366).

In the preamble to the proposed rule, OSHA's focus on identification and control of biomechanical risk factors in the workplace was based on two considerations. First, OSHA preliminarily concluded that there was substantial evidence of a clearly demonstrated causal relationship between exposure to physical risk factors and MSD outcomes (64 FR 65926), and that most researchers who studied the etiology of MSDs placed emphasis on biomechanical risk factors. Second, research into role of psychosocial risk factors in the etiology of MSDs was considered to be a less mature field than that addressing the role of biomechanical risk factors, characterized by emerging methodology, as pointed out by Dr. Martin Cherniak at the hearing (Tr. 1307), and sometimes by inconsistent results. Thus, most interventions designed to address work-related MSDs focused on biomechanical, rather than psychosocial factors.

The 1997 NIOSH review (Ex. 26–1) on which OSHA relied heavily, examined psychosocial risk factors that might contribute directly and indirectly to musculoskeletal illness and injury. The review noted that the results from the literature were not entirely consistent, and that a lack of consensus on standard measurements and procedures might be one reason for lack of consistency. Perceptions of intensified workload, monotonous work, low job control, low job clarity, and low social support were associated with MSDs in some studies. NIOSH found that these associations, despite the variance in methods used to assess these factors, were significant in the better studies; however, the size of effect was relatively weak compared to that of the biomechanical variables.

In his testimony, Dr. Frank (Tr. 1343–1345, 1397–1398) discussed the reasons for this inconsistency, relating it to the field being in the embryonic stage of understanding psychosocial effects, and to imperfect measurement instruments. He pointed out that the Institute for Work and Health study discussed below (Kerr *et al.*, 2000, Ex. 38–82) did not confirm findings of Bigos *et al.* (1991a, b, Exs. 26–1241, 26–1242, 1992, Ex. 26–1393) or Krause (1998, Ex. 500–87–2) that low job satisfaction contributed to risk. In contrast, Dr. Frank (Tr. 1344) noted that, in newer studies that simultaneously assessed the effect of physical and psychosocial factors, biomechanical loads make a consistent and generally stronger contribution to MSD outcomes.

Although psychosocial exposure assessment has grown rapidly in the last decade and is characterized by continually improving methodological developments, it is still a relatively young field. Measurement methodologies are not well standardized; this was addressed by Dr. Barbera Silverstein, who testified that there was no consensus on the kinds of psychosocial issues that should be studied or how they could be assessed ''with the same rigor that has been * * * looked at [for] physical load factors'' (Tr. 17444).

In addition, less is known about the causal relationship between psychosocial factors and MSDs. Many studies performed so far have been cross sectional, thus making it difficult to evaluate the temporal nature of the association (*i.e.,* whether psychosocial factors preceded the MSD or whether the presence of a disorder led to negative psychosocial outcomes). Dr. Punnett addressed this issue in her testimony:

> * * * [S]ince psychosocial factors may be perceived and reported differently by the worker after the development of musculoskeletal disorders, the reported associations are particularly difficult to interpret with respect to * * * [etiology].
>
> The occurrence of a work-related musculoskeletal disorder * * * may itself cause psychosocial strain. And that strain may also subsequently slow or interfere with the recovery process without necessarily having been involved in the initial etiology. In this context, we should note that associations with cross-sectional * * * [studies] with physical exposures are far less ambiguous. [Tr. 869–870]

As a result, associations found between psychosocial exposures and MSD outcomes are, relative to biomechanical associations, less consistent and generally weaker (NAS, 1999, Ex. 26-37). Further, the underlying mechanisms are still not nearly as well understood as those developed for biomechanical associations (Tr. 1344–1345, NAS, 1999, Ex. 26–37). Similarly, understanding and evaluating psychosocial interventions is also in its infancy, making it difficult to design appropriate interventions.

None of the studies cited by either proponents or opponents of an ergonomics standard can demonstrate that any of the risk factors measured, whether biomechanical, psychosocial, personal, or demographic, can completely explain an increased prevalence or incidence of MSD outcomes. (In other words, the combined contribution of all factors to statistical models never comes close to explaining 100 percent of the variance between exposure groups in the outcome measure; there are always other, unmeasured factors involved.) Dr. Tapio Videman (Ex. 32–241–3–20), Dr. Arthur Barsky (Ex. 500–118–1) and most other researchers agreed that a simple biomechanical model of tissue wear and tear is not sufficient by itself to explain disease development in humans, which is characterized by complicated interactions with external environmental factors and individual characteristics. In fact, testimony at the hearing (Tr. 868, 1264, 5942–5943) made it clear that considering psychosocial and biomechanical factors to be separate kinds of exposures is a somewhat artificial distinction in that the two classes of stressors are strongly linked, both resulting from core aspects of the organization: its technology, culture and work organization.

For example, Dr. Punnett testified that

> There is also a recognized overlap between some characteristics of physical and psychosocial work environment.
>
> A repetitive, monotonous job on a machine paced assembly line can be described equally well by the ergonomist as consisting of stereotyped repetitive motion patterns with rigid pacing and few rest breaks or as having poor psychological job content with few opportunities to make decisions, work collaboratively with co-workers, utilize existing skills or learn new ones.
>
> And I suggest that the worker performing that job would be hard pressed to make a distinction between the physical and the psychosocial characteristics of that job. [Tr. 868–869]

Ms. Sue Rahula, an ergonomist technician with United Auto Workers, described how biomechanical exposure and the presence of an MSD can affect worker morale, which can be reflected in negative psychosocial outcomes:

> When you're feeling pain your morale is going to be low, your discomfort level is low, your attitude is bad, and you may be one of the silent sufferers. * * * When * * * we take our risk factor checklist out and we verify that, yes, these postures are awkward postures and when you add that along with the forces and the exertions that you're using that that's a possibility it sure could cause pain. It's no wonder the morale becomes low. And they [biomechanical and psychosocial factors] do intertwine. But the pain is usually the cause of [low morale], in my opinion, from what I see. [Tr. 5942–5943]

These underlying sources of biomechanical and psychosocial exposures can themselves be seen as a single exposure category known as organizational exposure (Warren, 1997, Ex. 38–72, Warren *et al.*, 2000a, b, Exs. 38–75, 38–73, Shannon *et al.*, 1996, 1997, Exs. 26–1368, 26–1369), which, as Dr. Warren described, recognizes that ''the way work is organized will have an effect on the levels of both biomechanical and psychosocial work stresses'' (Tr. 1264).

Summary of Primary Literature on Biomechanical and Psychosocial Factors

OSHA's review of the literature presented below shows that most of the best studies available suggest that MSDs are the result of a complicated combination of biomechanical and psychosocial factors, with the prevalence or incidence of MSDs being generally more strongly associated with biomechanical risk factors. Given the present state of research into MSD etiology, there can be little doubt that a multifactoral model, incorporating both biomechanical and psychosocial risk factors, would best explain the differences in MSD prevalence or incidence seen among various groups of workers. Nevertheless, from the testimony presented above and the review of the literature that follows, OSHA concludes that biomechanical risk factors contribute independently from psychosocial factors to MSD etiology, that the association between the risk of MSDs and exposure to biomechanical risk factors has been observed to be generally stronger than for psychosocial factors, and that, consequently, it is reasonable to design interventions that focus on exposures to biomechanical risk factors to reduce the risk of MSDs in exposed workers.

Because the scientific literature summarized in this section addresses the relative strength of association between MSD risk and two broad categories of workplace factors, and because of the potential for interacting or modifying effects between biomechanical and psychosocial factors, it becomes particularly important to consider certain elements of epidemiological study design to ensure that study results are appropriately interpreted. These design considerations include the following:

Best study design. Epidemiological studies can be of three general designs: cross-sectional, case-control, and prospective (longitudinal) cohort. Dr. Stanley Bigos presented a comprehensive review of the advantages and disadvantages of each study design (Ex. 32–241–3–4, pps. 7–9). OSHA also addressed general issues regarding study design and causal inference in a previous part of this Health Effects section. All researchers agree that prospective studies can most persuasively establish causality, with cross-sectional studies presenting the most potential problems in this area. In the absence of any other information, prospective studies are generally preferable. However, several factors may recommend against this design: in particular, the high cost of these studies and the dynamic nature of the modern workplace, which may change job classifications (and hence workers' exposures) over the follow-up period of the study.

Although cross-sectional studies identify associations and cannot by themselves permit a definite attribution of a causal relationship, it is still possible to draw inferences when one causal direction (*i.e.*, exposure precedes disease) is much more plausible than the alternative explanation (*i.e.*, disease precedes exposure). As Dr. Gerr noted in his testimony (Tr. 1525) the many cross-sectional studies showing an association between carpal tunnel syndrome and physical workplace factors strongly indicate that exposure to these workplace factors causes disease. This conclusion arises in part because it is illogical to postulate that the presence of CTS would cause exposure to physical factors (*i.e.*, workers select themselves into physically harmful jobs on the basis of disease status). Dr Gerr testified that this would be ''like saying cancer causes smoking. It's as wrong as it is silly to hear'' (Tr. 1525). However, for psychosocial factors such as poor job satisfaction or low supervisory support, it is more difficult to logically infer or exclude a temporal relationship between a psychosocial factor and an MSD; this was described by Dr. Punnett in her testimony (Tr. 869). That is, it cannot be known whether having poor job satisfaction preceded development of the MSD or whether the presence of the MSD is causing a worker to become less satisfied with their job. Thus, in evaluating the causal nature of psychosocial factors, the use of a prospective study design that follows groups of workers over time becomes particularly important to evaluate the temporal relationships between exposure to biomechanical risk factors, psychosocial factors, development of MSDs.

In addition, as was the case with the biomechanical literature reviewed in earlier parts of the Health Effects section, determination of exposure and health outcome by objective means, such as direct observation or measurement of exposure and medical assessment of health status, is preferable over sole reliance on worker self-reports because objective measures rule out the possibility of reporting bias (*e.g.*, the possibility that a worker's disease status might influence the self-report of exposure). This design consideration points to another difficulty in studying the role of psychosocial factors in that they can only be assessed by administering questionnaires or interviews.

Simultaneous assessment. It is obvious that to accurately assess the relative contribution of biomechanical and psychosocial risk factors to MSD causation and exacerbation, both classes of exposure must be measured.

Address collinearity. Levels of both biomechanical and psychosocial risk factors are in large part the result of the way work is organized, the technology and sector of the company, and the organizational policies and culture that drive work organization. Thus the two classes of stressor are generally highly correlated in a workplace (Tr. 868–869, 1264, 5942–5943). Concurrent analysis of exposure-outcome associations must be very careful to avoid modeling problems that arise from collinearity.

Assess both stressor categories with equal precision. Some studies assess both categories of exposure, but assess one with more precision or detail than the other. The category characterized in more detail presents fewer opportunities for non-differential exposure misclassification (which biases results towards a lower effect) and will thus show artificially elevated relative associations with outcome. Dr. Wells stated that a factor measured with poor precision in an epidemiological study will often not appear as a risk factor in statistical modeling (Tr. 1355).

Ensure adequate variance in all measures. Studies that assess both categories of exposure, but with little variance between exposure groups in one or the other category of exposure will generally not find effects associated with that category or measure. Regression analysis (a standard modeling method in many studies) cannot assess the contribution of an exposure if its magnitude or intensity is essentially the same in all study participants.

Assess both stressor categories at the same individual or group level. Studies that assess both categories of exposure, but at different levels of analysis (*i.e.*, the level of the individual worker versus groups of workers), will generally not find an effect for the variables measured at a higher (group) level of aggregation; this was addressed by Dr. Frank in his testimony (Tr. 1364–1365). For example, the Boeing study (Bigos, *et al.*, 1991a, b, Exs. 26–1241, 26–1242, 1992 Ex. 26–1393) assessed psychological and emotional variables at the individual level and biomechanical variables at the group level. This error also reflects violation of the preceding two criteria since measurement at the group level reduces both precision in the biomechanical exposure measure (compared to measuring exposure at the individual level) and variance in biomechanical exposure between groups. When one variable is aggregated or represented at the group level, as in the Bigos measurement of biomechanical risk, the variations in exposure within each group are lost; internal variance within each group is reduced to zero.

The studies summarized below relied on assessment of both biomechanical and psychosocial factors in the workplace. Thus, in accordance with the second criteria described above, studies were excluded if they did not assess one class of stressor or did not include both classes in multivariate analysis. Such studies are useless for the exploration of combined biomechanical and psychosocial effects.

The majority of the studies below demonstrate at least equal, and often stronger, associations with biomechanical stressors than with psychosocial. This fact, combined with the independent effects of both stressor classes, as discussed above, is sufficient to support OSHA's focus on biomechanical risk factors in the final rule. However, relative magnitude of the associations for biomechanical and psychosocial risk factors should only be seen as a qualitative indicator of relative strength of association with MSD prevalence or incidence. Actual quantitative effect sizes may not be comparable within or between studies for a number of reasons, including:

- Use of different measurement scales;
- Use of different analytical strategies to categorize risk levels; and

• Use of different outcome measures in different studies.

Table V–14. summarizes the key features of the design of each study as well as the range of measures of association for biomechanical and psychosocial factors.

Wickstrom & Pentti 1998 (Ex. 500–121–77). This 2-year prospective study of 117 white-collar and 189 blue-collar workers in two metal industry facilities assessed both biomechanical and psychosocial exposures (4 items each) at baseline, using equivalent levels of detail. Back pain was assessed twice in the follow-up period by questionnaire, and data on sick leave attributed to back pain and other MSDs (doctor diagnosis if over 3 days) was obtained from company records. The exposure assessment at baseline plus physician diagnosis at follow-up made this design capable of strongly implying causal status to both physical and psychosocial risk factors. As predictors of self-reported LBP, 3 physical exposures were predictive for both white collar (RRs: 2.82–6.19) and blue-collar workers (RRs: 2.49–3.67). Since other authors (Marras, 2000, Ex. 500–121–46) have hypothesized that psychosocial exposures have less effect if the physical load is high, it is interesting that psychosocial stress was predictive of LBP in white-collar workers, while none of the 4 psychosocial exposures were significantly predictive in blue-collar workers. However, sick leave was predicted for blue-collar workers by both biomechanical exposures (RRs: 1.72–2.04) and psychosocial (RRs 1.58–1.99). In general, this study supports the interpretation that MSDs are caused by both classes of risk factor, with biomechanical showing stronger effects.

TABLE V–14.—STUDIES ASSESSING BOTH BIOMECHANICAL AND PHYSICAL RISK FACTORS

Reference	Number of subjects	Study type	Exposure measure	Outcome measure	Study design	Results: outcome and effect
Association with Biomechanical Factors Stronger than with Psychosocial Factors (or effect size not reported)						
Wickström & Pentti (1998).	306	3	1	1, 2, 3	all	LBP & sick leave due to LBP; Physical RR: 1.97–6.19; Psychosocial RR: 1.58–1.59.
Bergqvist *et al.*(1995)	260	1	2	3	all	UE/LBP sympt./MD diag.; Physical OR: 3.1–7.4; Psychosocial OR: 2.1–7.4.
Kerr *et al.*(2000)	381	2	3	1	all	Reporting of LBP; Physical OR: 1.7–3.0; Psychosocial OR: 1.6–2.6.
Koehoorn *et al.*(1999)	4020	3	2	2	a, c	MSD symptoms & claims; Physical RR: 1.41–4.65; Psychosocial RR: 0.45–2.78.
Krause *et al.*(1998)	1449	3	1, 2	2	b, c	Spinal injury through WC; Physical OR: 3.04 (driving cable car); 0.37 (part-time driving: 20–30 hrs); Psychosocial OR: 1.50–1.56.
Latko *et al.*(1997, 1999)	352	1	2	1, 3	all	Symptoms, MD Dx of CTS; Physical OR (high repetition vs. low rep.): 2.32–3.23; Psychosocial OR: n.s.
Latza *et al.*(2000)	230	3	1	1	all	Self-reported LBP; Physical PR: 1.8–4.0; Psychosocial PR: n.s.
Leclerc *et al.*(1998)	1210	1	1	3	all	CTS by signs or NCV; Physical OR: 1.90–2.24; Psychosocial OR: 1.59–2.24.
Linton (1990)	22,180	3	1	1	all	Neck & LBP symptoms Univariate ORs; Physical: 0.86–2.95; Psychosocial: 1.15–2.60; Combined ORs: 2.42–3.65.
Ono *et al.*(1998)	575	1	1	3	all	Epicondylitis, MD Dx; Physical OR: 1.7; Psychosocial OR: 1.2.
Videman *et al.*(1989)	199	3	2	1	b, c	Incidence of back injury; Low skill OR: 37–156 (if also 3 hrs. strenuous working postures)
Bernard *et al.*(1992, 1994).	973	1	1, 2	1	all	UE symptoms; Physical OR: 1.4–2.5; Psychosocial OR: 1.4–1.7.
Faucett & Rempell (1994).	150	1	2	1	all	UE symptom severity, (effect measured by R^2 change): Physical: 0.11–0.15; Psychosocial: 0.03–.12.
Heliovaara (1987)	*592	3	1 (occ.)	3	none	Hospital Admission for disc herniation/sciatica; Occupational RR: 2.2–3.0; Psychic Distress: NR.
Josephson & Vangård, 1998.	269	2	1	1	all	LBP medical visit; Physical OR: 2.3–8.7; Psychosocial OR: n.s.
Svensson & Andersson (1981).	940	**1	1	2	all	LBP sickness absence; Heavy Lifting (effect NR); Reduced overtime/monotonous work (effect NR).
Thorbjörnsson *et al.*(2000).	484	2	1	1	all	LBP med. visit or absence; Physical OR: 1.7–2.2; Psychosocial OR: n.s.; Interaction OR: 3.1–3.7.
Vingård *et al.*(2000)	2118	3	1	1	a, b	Care-seeking for LBP; Physical RR: 1.8–2.9; Psychosocial RR: 1.5–1.6.
Warren *et al.*(2000a)	845	2	1	1	all	NIOSH MSD case def.; Physical OR: 1.89–2.13; Psychosocial OR: 1.56–1.69.
Waters *et al.*(1999)	284	1	1, 2	1	all	Prevalence of LBP; Lifting Index OR: 1.04–2.20; Satisfaction OR: 4.57–7.65.
Burt *et al.*(1990)	834	1	1	1	all	UE Symptoms; Physical OR: 2.0–4.1; Dissatisfaction OR: 1.9–2.3.

TABLE V–14.—STUDIES ASSESSING BOTH BIOMECHANICAL AND PHYSICAL RISK FACTORS—Continued

Reference	Number of subjects	Study type	Exposure measure	Outcome measure	Study design	Results: outcome and effect
Lemasters *et al.*(1998)	522	1	1	3	c	Pain, all body parts, self-report and MD Dx; Physical OR: 2.3–3.5; Psychosocial OR: 1.6–2.9.
Scov *et al.*(1996)	1306	1	1	1	all	UE and low back symptoms; Physical OR: 1.64–2.80; Psychosocial OR: 1.43–2.04.
Warren *et al.*(2000b)	7712	1	1	1	all	MSD symptoms & pain; Physical β: 0.06–0.16; Psychosocial β: 0.04–0.12.
Hales *et al.*(1992, 1994)	533	1	1	1	a, b	UE MSD symptoms; Physical OR: 1.1–3.8; Psychosocial OR: 1.1–3.5.
Hoekstra *et al.*(1994)	108	1	1	1	a, b	MSD symptoms; Physical OR: 3.5–5.1; High Control: OR 0.6.
Houtman *et al.*(1994)	5865	1	1	1	b, c	Complaints: muscle/joint & back; chronic back problems; Physical OR: 1.36–1.62; Psychosocial OR: 1.20–1.35.
Association with Psychosocial Factors Stronger than with Biomechanical						
Viikari-Juntura & Riihimaki (2000).	5179	3	1	1	all	Radiating neck pain; Physical OR: 1.2–2.3; Psychosocial OR: 1.1–6.1.
Waters *et al.*(1999)	284	1	1, 2	1	all	Prevalence of LBP; Lifting Index OR: 1.04–2.20; Satisfaction OR: 4.57–7.65.
Elberg *et al.*(1995)	637	1	1	1	all	Neck & shoulder symptoms; Physical OR: 1.2; Psychosocial OR: 1.2–1.3.
Sauter (1984)	333	1	1	1	all	Somatic complaints; Physical β: 0.16–0.21; Psychosocial β: 0.19–0.26.
Warren *et al.*(submitted)	7712	1	1	1	all	LBP, absenteeism; Physical OR: 1.45–1.88; Psychosocial OR: 1.32–2.27.
Biomechanical Effect Not Significant						
Leino & Hänninen (1995).	902	3	1	1, 3	b, c	Back/limb symp. & MD Dx; Physical β: n.s.; Psychosocial β: .110–.146.
Bigos *et al.*(1991a)	3020	3	1, 2	2	none	Reporting back injury; Physical RR: n.s.; Psychosocial RR: 1.34–1.70.
Svensson & Andersson (1989).	1746	1	1	1	all	Low back pain; Physical n.s.; effect NR; Fatigue, dissatisfaction, worry; sig., but effect NR.

n.s.: not significant
NR: controlled for factor, but effect not reported
Table only notes statistically significant effects ($p<0.05$)
Key:
- Study Type:
  - 1—Cross sectional
  - 2—Case-control/Referent
  - 3—Cohort/Prospective
- Exposure Measure:
  - 1—Worker self-report
  - 2—Observation of job
  - 3—Instrumentation
- Outcome Measure:
  - 1—Worker self-report
  - 2—Observation/record
  - 3—Clinical findings
- Study Design
  - a—Biomechanical and psychosocial factors studies with equal precision
  - b—Biomechanical and psychosocial factors assessed at same individual or group level
  - c—Adequate variance between groups in all measures

* case 2140 con.
** retro. outcome

Bergqvist, Wolgast, Nilsson, Voss 1995 (Ex. 26–1195). hese investigators found a number of upper extremity diagnoses to be consistently associated with standard biomechanical risk factors (especially postural stressors, ORs 2.2–4.4, and lack of rest breaks, ORs 2.7–7.4); some personal factors (especially age and presence of children at home), task flexibility (OR 3.2) and quality of peer contacts (ORs 2.1–4.5) had independent associations. Although the study was cross-sectional, confidence in study findings is improved by the detailed physical examination used to determine outcome and the broad array of exposure measures (including individual factors, non-work risks, work organizational factors and biomechanical factors). Muscle problems in each body location showed a different pattern of personal, psychosocial and biomechanical stressor associations.

Faucett and Rempel 1994 (Ex. 38–67). his study of 150 newspaper editorial work found that upper extremity pain and numbness symptoms in VDT workers were related primarily to postural variables (R^2 changes 0.11–

0.15), with smaller additions to model R^2s from psychological demands, decision latitude, and employee relationship with the supervisor (R^2 changes 0.03–0.12). The effects of postural variables on upper torso pain and stiffness were greater than those for pain and numbness (R^2 changes 0.19–0.32), while psychosocial effects were reduced (R^2 changes 0.01–0.08). Interaction terms between keyboard height and psychosocial variables added to the model R^2s (R^2 changes 0.04–0.15), suggesting that the effect of biomechanical variables can be modified by psychosocial variables. In this study, biomechanical stressors were clearly the dominant factor, but the size of the effect for interaction terms may have meaning for the mechanism of psychosocial action as being an effect modifier.

NIOSH Health Hazard Evaluations (Exs. 26–439, 26–842, 26–725). Three cross-sectional NIOSH studies, at the L.A. Times (Bernard, Sauter, Petersen, Fine, & Hales, 1992, Ex. 500–165–20, 1994, Ex. 26–439), Newsday (Burt, *et al.*, 1990, Ex. 26–842) and two Social Security Administration teleservice centers (Hoekstra *et al.*, 1994, Ex. 26–725) found associations of biomechanical risk factors (in particular, duration of VDU work) with MSD symptoms, while also finding independent associations of these symptoms with several psychosocial factors. Another NIOSH HHE at U.S. West Communications (Hales *et al.* 1992 (Ex. 26–727), 1994 (Ex. 26–131) did not find associations between symptoms and physical workplace characteristics other than use of bifocal glasses (OR 3.8), because the standardized workstations presented virtually no variance in biomechanical measures. Thus, psychosocial factors were dominant in the models, although work pressure (OR 1.1–1.2), workload surges (OR 1.2) and information processing demands (OR 1.2) probably represent a combination of physical and psychosocial exposures. See Table V–14. for strength of association estimated by multivariate logistic regression models in all these studies.

Kerr, *et al.*2000 (Ex. 38–82). Researchers at the Institute of Work and Health (IWH) have carried out several well-designed studies measuring both biomechanical and psychosocial stressor levels in detail. These studies demonstrate the independent contributions of biomechanical, psychosocial and organizational factors to models explaining back injury and accidents (Shannon *et al.*, 1996, 1997, Exs. 26–1368, 26–1369). The most recent IWH study (Kerr, *et al.*, 2000, Ex. 38–82), performed in concert with the Ontario Universities Back Pain Study (OUBPS) group, is a case-control study reviewed in detail by John Frank (Ex. 37–27). Subjects reported levels of physical demands (including perceived exertion) as well as psychosocial factors. In addition, videotape analysis and biomechanical modeling provided quantifiable estimates of actual spinal loading. These biomechanical measures acted independently to substantially increase risk of workers reporting new cases of LBP, after controlling for individual and psychosocial factors. In final models, the biomechanical risk factors demonstrated ORs of 1.7–3.0, while psychosocial risks were associated with ORs of 1.6–2.6. This study improved on earlier study designs by directly measuring forces on back during job performance. The case-control study also matched controls by actual job, allowing analysis of the degree to which job exposures influenced self-reported LBP. Compression, peak shear force, peak hand force were associated with doubled risk of LBP reporting. These findings are consistent with much of the other epidemiological data reviewed in this section. Thus this study strengthens confidence in the results of other studies that rely on less detailed exposure assessment and/or self-reported exposures and outcomes.

Krause *et al.*1997 (Ex. 38–267), 1997 (Ex. 38–266), 1998 (Ex. 500–87–2). Niklas Krause and colleagues, studying a cohort of San Francisco drivers, examined relationships between biomechanical and psychosocial exposures and neck and shoulder outcomes. The cross-sectional analyses (Krause *et al.*, 1997a, Ex. 38–267, 1997b Ex. 38–266) determined that both biomechanical and psychosocial job factors were separately and simultaneously associated with non-disabling neck and back pain. The 5-year longitudinal follow-up of this cohort (Krause *et al.*, 1998, Ex. 500–87–2) found that workers' compensation cases of spinal injury were predicted by a combination of biomechanical (measured by hours driving) and psychosocial risk factors at baseline. (See Krause testimony, Ex. 37–15). The physical risk factors addressed by this measure of hours spent driving included prolonged sitting, twisting/bending, vibration, and use of foot pedal (Krause testimony, Tr. 1376, Ex. 37–15). Although all measures were gathered at the same (individual) level, the surrogate measure for biomechanical exposure (hours spent driving) was a more generalized measure than the psychosocial data and thus subject to greater non-differential misclassification and consequent dilution of effect in statistical modeling. Psychosocial stressors demonstrated, on average, higher ORs than the surrogate physical measure of hours spent driving. This is an example of the fourth study design criterion discussed above: the factor measured in greater detail has a greater likelihood of showing stronger associations in the modeling. The fact that a biomechanical effect still emerged in the modeling strongly suggests that if physical exposures were measured in the same detail as psychosocial exposures, they would have demonstrated a larger effect in modeling; however, it cannot be known whether the resulting size of the effect for biomechanical factors would have surpassed that for psychosocial factors. For cable car operators, biomechanical factors were more strongly associated with back cases than were psychosocial factors.

In his written comments, Dr. Nortin Hadler (Ex. 32–241–3–8) demonstrated a basic misunderstanding of the research by taking the Krause studies to task for showing a biomechanical effect only for cable car drivers. The data did show that only cable car drivers' injury rate was significantly elevated when *compared* to diesel bus drivers. However, the pooled data for *all* drivers showed a highly significant increase (2.7 times) in injury rate between drivers who worked 20–30 hrs per week compared to those who worked 31–40, suggesting a significant effect related to biomechanical factors. Hours-per-week-driven was the study's surrogate measure for exposure to physical risk factors.

Latko *et al.*1997 (Ex. 38–122), 1999 (Ex. 38–123). These researchers performed a cross-sectional study with some of the most detailed exposure assessments to be found in the literature. The study, described elsewhere in the testimony (Franzblau, Ex. 37–3, Armstrong, Ex. 37–21) measured a wide variety of demographic, personal, and exposure variables, including 13 psychosocial parameters. It is distinguished by precise measurement of exposure variables and several levels of outcome measurement objectivity, ranging from symptom reports, through physical findings, to nerve conduction velocity (NCV) results. The contribution of the psychosocial variables did not reach significance in the final modeling, strongly implying that the effect of biomechanical factors predominates in these 3 manufacturing plants (testimony by Armstrong, Ex. 37–3, Franzblau, Ex. 37–21).

Nortin Hadler (post hearing comments, Ex. 500–118–1, p 7) cited this study as evidence for a lack of a significant association between repetitive motion and decrements in median NCV. These results were, in fact, marginally significant. Moreover, if a more conservative definition of CTS was used, (*i.e.,* 0.8ms threshold plus positive hand diagram report), the association was significant (Franzblau testimony, Ex. 37–21). In addition, Dr. Hadler failed to note either the wide range of significant associations found for repetition, symptom reports and tendinitis as indicated by physical exam findings, and that these associations did demonstrate a positive exposure-response relationship.

Warren 1997 (Ex. 38–72), Warren *et al.*2000 (Ex. 38–73). Nicholas Warren and colleagues at the University of Massachusettes at Lowell and at TNO, the Netherlands, performed analyses on the Dutch Monitor data set, collected from a broad sample of companies and industry sectors in 1993—a cross-sectional study. The data set contained completed questionnaires from 7,717 Workers in 528 companies that assessed in detail both workplace exposure to biomechanical and psychosocial risk factors and a variety of musculoskeletal and stress outcomes, as well as reports of extended sick leave. Controlling for gender, education and tenure on the job, the multivariate linear analyses found roughly equal contributions of both stressor classes to the pain and MSD symptom reports, with physical factors having a somewhat larger magnitude of effect (standardized regression coefficients of 0.06–0.16) than psychosocial (0.04–0.12). Logistic modeling of low back pain and absenteeism outcomes found similar results, with biomechanical ORs of 1.35–1.88 and psychosocial ORs of 1.32–1.64, excluding social support. However, low social support did demonstrate the highest OR (2.27) in the model explaining low back pain. The study was cross-sectional and thus could not definitively evaluate temporal associations. However its large size and wide range of companies and sectors allowed precise separation of biomechanical and psychosocial exposure-outcome associations, without collinearity problems.

Dr. Alf Nachemson criticized this study (post-hearing comments, Ex. 500–118–1), confusing it with a completely different study of a different database submitted to *Spine.* The results of this study are reported in a doctoral thesis (Warren, 1997, Ex. 38–72) and an article submitted to the Scandinavian Journal of Work Environment and Health (Warren *et al.,* 2000b, 38-73). Contrary to Dr. Nachemson's mischaracterization, the express purpose of this study was to simultaneously measure biomechanical and psychosocial MSD risk factors at the same level and degree of detail.

Warren *et al.*2000 (Ex. 38–75). Warren and colleagues from the University of Connecticut Health Center carried out a separate study of the Connecticut working population, using a random-digit-dialing study design. This cross-sectional study is one of the few to randomly sample workers with unreported cases of MSD (using the NHIS definition; Tanaka *et al.*1995 (Ex. 26-59)). Psychosocial and biomechanical variables were assessed at equal levels of detail. Logistic regression analysis found case status to be associated with a broad mix of psychosocial and biomechanical stressors, with biomechanical exposures showing somewhat higher odds ratios. Significant psychosocial ORs ranged from 1.56–1.69, while biomechanical ORs were between 1.89 and 2.13. Stressors were measured at equivalent levels of detail and demonstrated independent effects for psychosocial and biomechanical exposures.

Koehoorn, 1999 (Ex. 500–40). This doctoral thesis used a retrospective cohort design to follow 4020 health care workers from an acute-care hospital over a 4-year follow-up period, assessing outcomes of musculoskeletal symptoms and claims. Results varied by body location. In multivariate models explaining upper body symptoms, a biomechanical index showed risk ratios of 1.41–1.84, while psychosocial variables showed RRs ranging from 0.45–2.78. For lower-body symptoms, RRs for biomechanical risk factors ranged from 2.12–4.65; psychosocial variables generally did not reach statistical significance. Outcomes of compensation claims related to these two body areas showed similar ranges of effect. In subcohorts analyzed for departmental sicktime and overtime, increased sick time was associated with symptoms and claims, but increased overtime was not. The study design assessed detailed biomechanical factors by observation, but only by occupational title, while psychosocial factors were assessed by individual questionnaire. Thus, the relative strength of association may have been underestimated for biomechanical stressors. This large, carefully designed cohort study provides evidence for a multifactoral model of MSD causation, with physical factors being more strongly associated with MSD incidence.

Waters et al.1999 (Ex. 500–41–54). This study was designed to provide epidemiologic data linking the NIOSH lifting index (LI, a quantitative measure of manual lifting stress calculated with the revised NIOSH lifting equation) to prevalence of low back pain. Measurements used to calculate the LI were collected on a sample of workers over a 2–4 day period by trained observers. Workers also completed a self-administered questionnaire that included psychosocial items. In multivariate modeling, increasing values of the LI were associated with increases in period prevalence of LBP over the last 12 months, with an exposure-response relationship that reversed at the highest LI (>3). The authors noted that this drop in negative outcomes in the highest exposure category is seen in other studies and seems to indicate a ''healthy worker'' or survivor effect (representing the departure of workers with pain or high risk of back injury from highly stressful jobs). Psychosocial factors of demands, control and social support did not enter significantly into these models, perhaps because they were entered as continuous, not categorized, variables. However, a four-category measure of decreasing work satisfaction showed a significant exposure-response relationship with LBP. This high-quality study, which relied on independent measurement of physical job characteristics, demonstrated the combined contribution of physical and some psychosocial stressors to prevalence of LBP, with physical effects predominating in multivariate modeling.

Leclerc et al. 1998 (Ex. 500–41–85). This cross-sectional study of 1210 workers in 3 industry sectors incorporated a sophisticated mixture of individual measurement of both physical and psychosocial factors, combined with group-level assessment of cycle time and autonomy. Given the study design principles outlined above, the effects of these group-level factors may thus be underestimated. With this caveat, the research still demonstrated a combined contribution to physician-diagnosed CTS for cycle times less than 10 seconds (OR 1.90) and psychological ''problems'' (OR 1.41). Other physical and psychosocial factors dropped out of this model. In a final model incorporating the presence of just-in-time production organization at the plant, this factor replaced cycle time, with an OR of 2.24. Other physical and psychosocial risk factors were associated with marginal significance.

The work organization variable of just-in-time production is probably a surrogate for a combination of increased biomechanical and psychosocial risk. This study thus demonstrates the combined contribution of both types of risk. This study also found that industry sector did not enter significantly into the model when both physical and psychosocial risk factors were more precisely measured at the individual level.

Latza *et al.*2000 (Ex. 38–424). This prospective study of construction workers in Hamburg took detailed observational measurements of biomechanical stressors associated with a wide variety of construction tasks. Of the 571 workers who filled out baseline questionnaires, 285 individuals free of LBP were selected; 230 were followed up after 3 years. The physical stressors at baseline predicted subsequent 1-year prevalence of LBP (PRs: 1.8–4.0), while psychosocial stressors did not enter significantly into the models. This is somewhat surprising since, although the physical stressors were evaluated in detail, they were measured at the job level, while psychosocial factors were measured at the individual level. As noted above, this usually results in an underestimate of the physical stressor contribution relative to psychosocial factors.

Vingard *et al.*2000, MUSIC study (Ex. 500–41–51). The Swedish MUSIC project has consistently demonstrated combined associations of biomechanical and psychosocial stressors with back, neck and shoulder, and other disorders. This study assessed prospectively the individual and combined effects of physical and psychosocial exposures on subjects' seeking care for LBP over a 5-year period. Gender stratification reduced significance levels but demonstrated somewhat different exposure-outcome associations for males and females. For men, forward bending and manual material handling time, when compared to levels 5 and 10 years ago, were significantly predictive (RR 1.8 and 2.0 respectively) with a combined exposure having a RR of 2.8. This combined exposure was also significant for females (RR of 2.3). For both genders, a combination of physical stressors including metabolic stress was also a risk factor. Although included in these multivariate models, most psychosocial stressors did not enter significantly (exceptions were low work satisfaction and low skill use for males, RRs of 1.6 and 1.5, respectively). A subset of the study sample reflecting a combination of high physical load and high psychosocial load showed much higher RRs, but the sample size was small. Overall, the MUSIC study provides well-designed and detailed evidence that physical and psychosocial exposure combine in the etiology of LBP, with the physical stressors demonstrating stronger effects.

Houtman *et al.*1994 (Ex. 26–1230). This paper reported a cross-sectional analysis of pooled 1977–1986 results from the National Work and Living Condition Survey in the Netherlands. The study asked one question on work pace, four on intellectual discretion, and one on physical load. The items were all assessed at the same level of precision (dichotomous, yes/no) and at the same analytical level, but the greater detail in intellectual discretion assessment may have biased the estimated effects of that particular construct upwards. Multivariate logistic regression models were constructed to explain variance in 3 musculoskeletal outcomes: back complaints, muscle/joint complaints, and chronic back problems. Work pace was consistently associated with these outcomes (ORs 1.21–1.29) as was heavy physical load (ORs 1.36–1.62). Of the intellectual discretion items, only one, monotonous work, was consistently associated with musculoskeletal symptoms (ORs 1.29–1.35), but when all four items were combined, the scale demonstrated the strongest association of the study with chronic back pain (OR 2.10). Thus, in addition to providing more evidence for independent association of physical and psychosocial stressors with musculoskeletal outcomes, the study supports the hypothesis that psychosocial stressors have their strongest effect with duration of pain, not its inception.

Videman *et al.*1989 (Ex. 26–1155). This study is difficult to interpret, but is included because of its relevance to interventions. The researchers dichotomized graduating nursing students by skill level. Half the students had received traditional lifting training; half had received advanced, biomechanically-oriented training. Skill assessment was performed through video analysis of standardized tasks, not by simple assignment to trained or untrained groups. Nurses were also dichotomized by hours/day in strenuous postures (<3 hrs/day, >=3 hrs/day). In addition, the study collected extensive anthropometric, strength and psychological measures. Incidence of back injury was assessed at a 1-year follow-up. The results seem to confuse training level and activity level, but a combination of >3 hours/day of strenuous activity and low skill level significantly predicted self-reported incidence of back injury (ORs of 37 or 156, further stratified by high and low abdominal strength, respectively). The authors emphasized that ergonomic interventions must be coupled with training and describe the training as resulting in biomechanically less stressful lifting choices by nurses. They concluded that training is an effective intervention and ''the biomechanical and ergonomic components of training in patient-handling appear to be inescapable'' (Ex. 26–1155).

Thorbjornsson *et al.* 2000 (Ex. 500–71–49). This retrospective nested case control study examined a cohort of 484 subjects from the general population, examined first in 1969 and again, 24 years later, in 1993. Exposure information was collected retrospectively for the 24-year period and the 12 months previous to the 1993 interview. Outcomes measured were LBP that resulted either in a medical visit or sick leave more than 7 days. The study identified a small number of physical factors (heavy physical work, sedentary work) and psychosocial factors (poor social relations and overtime work) associated with LBP, as well as high load outside of work. Most importantly, the research demonstrated significant ORs for a wide variety of interaction terms between workplace biomechanical and psychosocial risk factors (ORs: 2.2–3.5). In final modeling incorporating the interaction terms, individual psychosocial effects became non-significant, but an interaction between poor social relations and overtime work showed an OR of 3.1–3.7 for men, depending on LBP onset time. The finding of significant interactions between biomechanical and psychosocial factors suggests that control of biomechanical risk factors in the workplace should reduce not only the effects associated with biomechanical risk factors, but the effects of their interaction with psychosocial exposures.

Boeing Study. (Bigos et al.1991 (Ex. 26–1241), 1991 (Ex. 26–1242), 1992 (Ex. 26–1393)).

These studies were discussed earlier in the Health Effects section. In addition, several witnesses who appeared at the public hearings (Frank, Krause, others, *e.g.* Exs. 37–27, 37–15) have explored the methodological problems with this study, which explain its finding that the only significant predictor of back pain reporting found was job dissatisfaction. In sum, the study assessed physical factors at the group level (although the articles never make clear the exact methodology), while assessing psychosocial and psychological variables at the individual level. Assessed at the group level, the variance in predictive physical factors was drastically reduced. For instance, Dr. Bigos stated (Bigos *et al.,* 1991b, Ex. 26–1242, testimony, Tr. 6908) that no-one was required to lift over 20 lbs., and no-one actually lifted more than 50. However, the analysis had no way to assign actual lifting frequency or compressive forces at the individual level. It is difficult to determine whether even the poor characterization of physical load approached statistical significance because the authors elected simply not to report results that were not significantly associated with outcomes (testimony, Tr. 6786). In addition to this measurement problem, psychosocial and psychological factors were measured with much greater precision. As noted above, these assessment differences virtually ensure the primacy of the better-measured factors, in this case the psychosocial factors, in statistical modeling.

In addition, the factors entered in the Boeing study models explained only an extremely small percentage of variance in the outcome; job satisfaction explained 2.2 percent and psychological variables explained 1.9 percent. All of the psychological, physical exam and medical history variables assessed in the study combine to explain only 8.6 percent of the variance (Bigos *et al.,* 1992, Ex. 26–1393). Thus, 91.4 percent of the variance in reporting of back pain is not explained by the combination of poorly measured physical risk factors and the more detailed psycho-emotional factors. This suggests relatively poor characterization of overall exposure.

The flaws noted above also pertain to the psychological factor assessment in this study. Psychological factors were measured at a much finer level of detail than physical factors, which were measured at the group level. Overall explanatory power of any of these measures was poor. As a minor point, specific to the psychological assessment, the study used non-standard and out-of-date instruments (Cherniack testimony, Tr. 1150).

Svensson and Andersson 1989 (Ex. 26–732). This study evaluated the association of a number of physical and psychosocial and psychological variables with incidence (retrospective) and prevalence of LBP in women. Both physical and psychosocial/psychological variables showed univariate associations with the outcome, but multivariate analysis found associations only with 3 ''psychological'' variables: dissatisfaction with the work environment, worry/tension at the end of the day, and fatigue. The analysis is not helpful to the separation of physical and psychosocial effects for three reasons. First, the study only reports the p-value range of the significant associations and does not report effect size, thus making it impossible to tell if physical exposures were of near significance and to compare relative strength of association. Second, it is not at all clear whether variables of dissatisfaction and worry/tension represent a psychological exposure or an *outcome*, resulting from an underlying combination of physical and psychosocial/psychological workplace factors, or from underlying symptoms (see, Linton, 2000, Ex. 26–642). Most importantly, it is clearly a mistake to label ''fatigue'' a psychosocial variable. In fact, fatigue represents an integrated measure of all stressors, physical and psychosocial, encountered by the worker and may well be weighted towards the obvious biomechanical stressors. As such, it is not surprising that this measure might capture variance from the individual physical exposures tested in the study. (Recall how the combined index of psychosocial exposures in the Houtman *et al.*study, (1994, Ex. 26–1230) had the highest ORs in the study, while the individual items composing the index had much lower ORs.) As confirmation, it is interesting to note that these authors' earlier research (1983, Ex. 26–1158), which assessed a similar set of exposures but did not include the fatigue item, did demonstrate a contribution from a physical stressor (high degree of lifting). Thus, this research appears to be unable to accurately separate the contribution of physical and psychosocial/psychological factors to LBP.

Leino and Hanninen 1995 (Ex. 38–76). This paper reported the results of a prospective study begun in 1973, in 2653 industrial workers, including managerial and office positions. Nine hundred two of these participants were reexamined after 10 years. Outcomes were self-reported musculoskeletal symptoms and evaluations by physiotherapists. At follow-up, both self-reported symptoms and medical findings were predicted by one psychosocial scale (social relations, OR 2.63–3.41) and occupational class (OR 2.67–3.73). The only factor that partly captures physical load in this model is occupational class. A single, 4-level measure of physical load was also entered into the equation. However, this measure is much less precise than the 6-question scale (each item with 5 levels) assessing social relations. This unequal precision would bias the results towards the exposures measured with greater precision, the psychosocial factors.

The authors noted that their physical load measure did enter into the cross-sectional models at baseline, along with more psychosocial exposures (work content, overstrain) and occupation. It was surprising to find that physical load (a slightly more precise measure of biomechanical exposures than exposure) dropped out of final models while occupation class remained. Both physical load and occupation in this study represent biomechanical exposures assessed at a much less precise level than the psychosocial measures. This study, though provocative, cannot provide useful information about the relative strength of effect.

Summary of Literature Reviews

Several reviews have been published that have evaluated the literature dealing with work-related MSDs; many of these reviews included evaluations of studies that concurrently examined the effects from exposure to both biomechanical risk factors and psychosocial risk factors. In this section, OSHA summarizes the reviews contained in the rulemaking docket.

Burdorf & Sorock 1997 (Ex. 502–232). These authors reviewed 35 studies that collected quantitative information on exposures and back disorder outcomes. Eight of these studies assessed psychosocial and biomechanical risk factors simultaneously. Of these, six found positive associations of back disorders with a combination of physical and psychosocial exposures and two identified several of the physical factors to be significantly associated, while the psychosocial factor measured (job dissatisfaction) did not show a significant association.

The analysis identified lifting or carrying loads, whole-body vibration, and frequent bending and twisting to be the biomechanical risk factors having consistent associations with work-related back disorders. Unlike some other studies (*e.g.,* Leino & Hanninen, 1995, Ex 38–76), height and weight (as well as gender, exercise and marital status) were consistently not associated with back disorders in these studies. The review identified low job decision latitude and job dissatisfaction as possibly important predictors of MSDs, but the evidence was not consistent across studies with different designs. Although the majority of these eight studies acknowledged the importance of psychosocial factors, the generalization that emerges from them is that biomechanical factors were more consistently associated with back disorders.

Punnett and Bergqvist 1997 (Ex. 38–13). This review of a large international body of literature linking biomechanical and psychosocial factors to upper extremity symptoms and findings in computer users (classified by neck/shoulder, arm/elbow, and hand/wrist). The authors found strong, consistent evidence linking MSD development with biomechanical factors (hours/day and cumulative years of exposure, intensive or repetitive data entry, and non-neutral postures due to poor workstation design), while controlling for work organizational and psychosocial factors in 7 of the 72 papers included in the analysis. The work organizational factors included in 3 papers (repetitive work, work pressure and insufficient rest breaks represent a combination of physical and psychosocial risks. In 4 papers, this review found suggestive but inconsistent associations (making generalization impossible) between MSD symptoms and the psychosocial factors of low decision latitude, low social support, job insecurity and job dissatisfaction (Bergqvist *et al.,* 1995, Ex. 26–1195, Faucett & Rempell, 1994, Ex. 38–67, Kamwendo *et al.,* 1991, Ex. 26–1384, Hoekstra *et al.,* 1994, Ex. 26–725). The authors also noted the difficulty of using job dissatisfaction as a predictor for MSDs since it could easily be either a cause or consequence of an MSD.

Lagerstrom et al. 1998 (Ex. 38–102). In this review of studies relating to low back problems in nursing, 42 articles passed the inclusion criteria: 21 cross-sectional, 10 prospective, and 11 intervention (also prospective). One of the reviewers' quality criteria was that the studies include both physical and psychosocial exposure information. The authors noted that a problem in many of the studies was the assessment of physical stressor information at an aggregate or group level, while psychosocial exposures were assessed at the individual level. As noted above, this non-comparability would tend to underestimate biomechanical effect in relationship to psychosocial effect. Still, the authors conclude from their review that biomechanical and psychosocial exposures generally combine in their associations with or (in prospective studies) effects on back disorder outcomes. Looking at well-designed studies with dual exposure measurement, the authors report that ''[t]o our knowledge there are no studies that show that work organizational or psychosocial factors, as such, cause low-back problems.'' They do acknowledge the importance of these factors in the ''consequence and maintenance'' of low-back related disorders, through differences in pain perception and reporting behavior.

Bongers et al. 1993 (Ex. 26–1292). This article was one of the earliest reviews of the evidence for an association between psychosocial factors and MSD outcomes. The authors looked at 29 cross-sectional and 3 longitudinal studies addressing work-related psychosocial factors. Of these, 22 measured physical load, and the authors of this review did not think that the physical load assessment was of a high enough quality to specifically assign relative association effects to physical and psychosocial factors. Thus, this review is included to demonstrate how far the field has moved since 1993. Subsequent reviews and studies addressed in this section show that research in the intervening 7 years has moved towards more accurate characterization of biomechanical and psychosocial loads and defining their associations with MSD outcomes.

National Academy of Sciences, 1999 (Ex. 26–37). The NAS study (cited by Armstrong, Exs. 37–21, 37–1, 37–9 and others, Ex. 37–15, testimony) was discussed in OSHA's preamble to the proposed rule and is described in part B of this Health Effects section. It reviewed a number of studies that found strong evidence for biomechanical contribution to MSD etiology, controlling for psychosocial factors.

Linton, 2000 (Ex. 26–642). This paper is a careful literature review of studies addressing the association between psychological factors and back and neck pain. The author concentrated on individual psychological measures (*i.e.,* internal psychological factors) but also included some external psychosocial factors. Since many of the studies also assessed outcomes of disability and time to return-to-work (RTW), the author was able to provide evidence for his suggestion that psychological factors may play a greater role in these long-term outcomes.

The findings of this review are strengthened by its assessment of only prospective studies. This might allow an interpretation that the positive relationship found between various psychological factors and the outcomes of pain, disability, RTW time, etc. might represent a causal connection. However, there are two important caveats. Dr. Linton noted that longitudinal relationships of this sort may still mask reverse causal connections. The studies generally cannot determine whether some psychological ''predictor'' variables and the outcome variables are not *both* the result of initial or underlying pain. Secondly, he noted that the psychological variables identified in the 37 reviewed studies explain only part of the variance in outcome. Thus, the review's results are consistent with the multifactoral model of MSD etiology (including biomechanical, psychosocial, psychological and personal variables).

Despite the care with which the studies were selected and analyzed, however, the review did not identify the type of biomechanical exposures assessed in the studies or the level at which they were studied. Instead, it simply noted that 18 studies controlled for miscellaneous confounding factors, one of which was ''workplace factors''. No indication was given as to the nature of these factors and which of these 18 studies addressed ''workplace factors''. Given the age of some of the papers, controlling for other factors (instead of simultaneously assessing their effect) is understandable, but it renders the review useless in contributing to the central debate concerning relative contribution of biomechanical and psychosocial factors (*i.e.,* both external psychological and social workplace factors and internal psychological factors). To further compromise the utility of this review, the studies evaluated in this review included several that measured physical exposure at the wrong analytical level (*e.g.,* Bigos *et al.,* 1991, Exs. 26–1241, 26–1242) or at a reduced level of detail (*e.g.,* Leino & Hanninen, 1995, Ex. 38–76, Viikari-Juntura *et al.,* 1991, Ex. 26–1219), compared to the psychological factors. This review, although a significant contribution to the literature overall, provides no useful information concerning relative contribution of physical and psychological factors to MSDs.

Nachemson 1999 (Ex. 32–241–3–31). This article is a comprehensive review of the studies purporting to demonstrate that physical workplace factors are irrelevant to the development of back pain, injury and disability. Instead, the studies implicate personal biology and psychological factors, stress and psychosocial factors in the workplace, and the monetary incentives of the compensation system. Some of these studies have been addressed above (*e.g.,* Bigos, 1991b, Ex. 26–1242). In general, Dr. Nachemson's claim that these factors contribute to low back disorders is credible. Very few of the researchers cited above would deny their contribution. What is emphatically not credible is the claim that physical factors are thus not implicated.

There are 3 primary problems with this claim. First, many of the studies cited in the article have not assessed the role of physical factors at all or have assessed them at levels of analysis or detail that make examination of their contribution impossible. The results of these errors have been discussed above. These studies overestimate the role of non-physical risks and thus cannot address the question or relative effects of biomechanical and psychosocial exposures in the workplace.

Second, the basic conceptual gap in the Nachemson review is a failure to acknowledge and address the implications and mechanism of multifactoral causation. There is a broad literature of well-designed studies, both epidemiological and laboratory (reviewed above and in earlier parts of the Health Effects section) demonstrating that psychosocial and psychological factors can add to the effects of physical exposures or even potentiate them (interaction or effect modification) (see Linton, 1990, Ex. 26–977, for a clear example). Dr. Nachemson's reluctance to consider such effects is represented by his citation of the Valfors *et al.* (1985, Ex. 26–685) examination of LBP. This study reported that physical risk factors (poorly characterized by a physiotherapist and a physician) were similar in workplaces of controls and low back cases, while reporting case/control differences in psychosocial work environment (again, poorly characterized). Valfors thus attributed the back injuries in the case group to the psychosocial factors. The logical fallacy, of course, is to assume that this difference removes physical exposures from a causal role. The more logical explanation, especially in light of all the evidence for multifactoral etiology presented in this section, is that the *combination* of physical exposures and psychosocial exposures presented increased risk. A level of physical risk that is acceptable in a psychosocially benign work environment can combine with elevated levels of psychosocial risk to cause disorders.

Finally, many of the studies cited in this article confuse cause with effect. To continue with Dr. Nachemson's citation, Valfors concluded that the measured differences in work satisfaction were the cause of the low back pain episodes, when it is just as likely that the LBP itself affected patients assessment of their work satisfaction (see Linton, 2000, Ex. 26–642).

These three errors, together or individually, characterize many of the studies in the Nachemson article. In sum, this review, while useful in collecting a wide variety of studies addressing the complex issues of low back pain, disability, and management, does not demonstrate that physical workplace factors are not involved in the etiology of LBP. Nor does it demonstrate that workplace interventions directed towards reduction of biomechanical risk factors would be ineffective. His citation of the Daltroy (Daltroy *et al.*, 1997, Ex. 38–57) training intervention in the postal service, for example, is not a refutation of the central causal role of biomechanical exposures in the etiology of back injury. Rather, it is emblematic of the general failure of ''back schools'', when introduced in the *absence* of measures directed towards control of physical risk factors. Dr. Nachemson, himself, states in this review: ''[I]t is obvious that certain types of lifts and working positions should be avoided and this in particular applies to twisted lifts.'' Ideally, this review will advance the development of more effective intervention techniques that address the combination of risk factors presented by Dr. Nachemson.

Waddell & Burton 2000 (Ex. DC–151–A). This thorough review of management protocols for LBP includes evaluation of epidemiological and clinical studies addressing etiology of LBP. Because the review and recommendations focus primarily on medical management issues, it is not surprising that it concentrates on the psychosocial factors involved in pain perception, sickness absence, disability and return-to work. Most of the studies addressed above acknowledge the importance of psychosocial factors in medical management issues, not only for LBP but also for other musculoskeletal disorders. The evidence reviewed above corresponds with these authors' conclusions that low job satisfaction, ''unsatisfactory psychosocial aspects of work'' and individual psychosocial findings are risk factors for onset of LBP, health care use and work loss, but the size of that association is small to modest (strong evidence). The authors also noted that physical demands of work (manual materials handling, lifting, bending, twisting, and whole body vibration) can be associated with onset of LBP, increased LBP reports, symptom aggravation, and back ''injury'' (authors'' quotes). However, they find that the association ''appears to be'' weaker than those of individual, non-occupational and unidentified factors (strong evidence).

The authors make an elementary error in ascribing potential LBP causation only to dynamic back activities. Their noting the high prevalence of LBP in non-dynamic jobs, and even in the unemployed, is, of course, related to the well-established research findings that sedentary and constrained postures are also physical risk factors for back disorders (Putz-Anderson, 1991, Ex. 26–1255, Hoogendoorn *et al.*, 1999, Ex. 38–81, Burdorf & Sorock, 1997 Ex. 502–232).

More importantly, the studies used to provide ''strong evidence'' for various conclusions are sometimes categorized as being of high quality when, in fact, they violate some of the important epidemiological design criteria cited above. In particular, in making a case for primarily psychosocial causation, the authors used studies that measured biomechanical exposures inadequately (*e.g.*, Bigos *et al.,* 1991b, Ex. 26–1242, and others reviewed above) or studies that did not include both biomechanical and psychosocial factors in statistical modeling (Macfarlane *et al.*, 1997, Ex. 500–41–91, Papageorgiou *et al.*, 1997, Ex. 32–241–3–41). Several reviews are cited that, on closer examination, are only modest in their assessment of both psychosocial and biomechanical risk contribution, noting the problems with study design and, especially, the relatively few studies that assessed both exposures adequately and at equal levels of precision (Burdorf & Sorock, 1997, Ex. 500–232, Bongers *et al.*, 1993, Ex. 26–1292, Davis & Heaney, 2000).

Conclusions

Based on the rulemaking testimony, scientific studies, and literature reviews considered in this section, OSHA concludes that the evidence contained in the record supports a combined contribution of biomechanical and psychosocial risk factors to the onset, development and prolongation of MSDs. Biomechanical contributions to the etiology of work-related MSDs have been demonstrated to be more consistent than psychosocial factors across different study populations, and most well-designed studies reported stronger associations between exposure to biomechanical risk factors and an increased MSD prevalence or incidence than has been observed for psychosocial factors. However, it is not possible to determine the relative strength of association between biomechanical and psychosocial factors with any precision because of differences in measurement techniques used in the various studies to assess biomechanical and psychosocial factors, and because of the different ways in which psychosocial factors are defined by various investigators. Most importantly is the finding by several investigators that biomechanical and psychosocial factors influence MSD risk in independent fashon, which suggests that reductions in biomechanical exposures absent any change in psychosocial influences should reduce the risk of work-related MSDs.

Findings from published literature reviews of studies that conform to the epidemiologic design principles discussed above are consistent with the Agency's conclusions. Four reviews (Burdorf, Ex. 502–232, Punnett, 38–13, Lagerstrom, Ex. 38–102, NAS, Ex. 26–37) reported that biomechanical risk factors generally showed stronger and/or more consistent associations with elevated MSD prevalence or incidence than did psychosocial factors.

Three reviews reached an opposite conclusion (Linton, Ex. 26–642, Nachemson, Ex. 32–241–3–31, Waddell, DC–151–A); however, these reviews relied more heavily on studies where biomechanical factors were not evaluated at all, were evaluated in jobs having little variance in physical load, or were evaluated at different analytical levels or with less precision, or than psychosocial factors. All of these design flaws bias results towards increased psychosocial effects in modeling. It is on the basis of these reviews and the underlying studies that the Chamber of Commerce, Gibson, Dunn & Crutcher, and several of their scientific witnesses base their conclusion that psychosocial factors outweigh the importance of biomechanical factors in the etiology of MSDs. Accordingly, OSHA is not persuaded by these arguments, and finds the preponderance of evidence supports a multifactorial model of MSD causation involving both biomechanical and psychosocial factors acting independently on risk.

Moreover, testimony and evidence presented above suggests that biomechanical and psychosocial risk factors are, to a degree, inextricable (Punnett, testimony, Tr. 868, Kerr *et al.*, 2000, Ex. 38–82). The degree of influence each exerts on MSD risk is in large part determined by company characteristics and work organization, and their very separation is somewhat artificial. The final rule's focus on reducing exposures to biomechanical risk factors reflects the intervention strategy that has been emphasized in the literature and implemented by many sophisticated companies. Simply less is known about how to intervene effectively on psychosocial factors. However, this does not mean that biomechanical intervention will have no effect on psychosocial factors in the wortkplace. Because of the correlation and interactions between biomechanical and psychosocial factors in their associations with MSD outcomes, interventions focused towards biomechanical stressor reduction are likely to have a positive effect on levels of psychosocial stress. The arguments of Bellamy and Vendor, above (testimony) are addressed by the reality of this close correlation between stressor types.

The intervention literature demonstrates that the very fact of a company's undertaking even a limited program to control biomechanical exposures is, *de facto*, also a psychosocial intervention. If workers report MSD symptoms and the company responds with workplace alterations, medical intervention, training, and the other program elements in the final rule, this response often represents a reduction in excessive psychological demands, an increased sense of control, and an improvement in the social support structure of the workplace. In Sweden, Kvarnstrom (1992, Ex. 38–69) found that changes in the physical work characteristics, combined with changes in the psychosocial work environment (increased variety, decision-making latitude, and individual control over the work situation) in a small department of a large, multi-national company greatly reduced the high rate of absenteeism and turnover due to musculoskeletal disease. In the United States, Smith and Zehel (1992, Ex. 38–70) reported that employee focus groups identified the need for physically-oriented engineering changes as well as psychosocial changes in a meat-processing plant; the combined intervention resulted in decreased physical symptoms for part of the work force. Worker participation in problem identification and solution development is a central feature of many successful approaches to work environment change and is at the core of the proposed rule. For example, Pasmore & Friedlander (1982, Ex. 38–71), addressing an outbreak of upper extremity disorders in a United States electronic assembly facility, designed an intervention in which the employees determined the data to be collected and solutions based on these data. While this level of employee involvement focused on reducing biomechanical risk factors, it also increased employee participation and task control and altered role relationships within the organization.

A number of witnesses testified at the hearing that ergonomic programs designed to address biomechanicla factors have positive effects on psychosocial factors that have been implicated in MSD etiology. Dr. Warren explained why this is the case:

> I think what happens hypothetically and in my experience is that when you control a biomechanical workpalce factor, you are de facto making a small psychosocial intervention in the workplace.
>
> When * * * somebody says [''my back hurts''] and it's followed * * * immediately by [''and nobody cares''], you know that there's a psychological problem in that workpalce. So I think that, yes, * * * a control of a biomechanical risk factor with no change in a psychosocial environment would reduce the chance of injury, but that it would probably also change the psychosocial environment to a small degree. [Tr. 1265]

Dr. Rosecrance (Tr. 2319–20) presented a specific example. He noted that the biomechanical intervention in his study of the Cedar Rapids Gazette resulted not only in reductions of MSDs, but also improvements in the company social structure.

Mr. Dave Alexander believed that the employee participation provision of the proposed standard would address psychosocial issues:

> * * * the opportunity for worker participation in the form of contributing information, suggesting solutions, having a mechanism to report problems would, in fact, tie in with the psychosocial issues that would be important in the workplace. [Tr. 2713–2714]

Similarly, Dr. Silverstein testified that providing workers with basic information on MSDs and employee involvement in the ergonomics program increases the decision latitude for workers [Tr. 17445].

These studies and testimony indicate that the basic precepts of management commitment and employee participation contained in the final rule, while forming the administrative infrastructure of an ergonomics program focused on physical risk abatement, has the potential to have positive effects on the psychosocial characteristics of the work environment.

6. Final Rule's Consistency With Medical Guidelines

Several commenters questioned whether the program elements of OSHA's final rule were consistent with existing medical practice guidelines, primarily with respect to diagnosing and treating low back pain, but also diagnosing and treating other MSDs. For example, when referring to the Agency for Health Care Policy and Research (AHCPR) low back pain guidelines, Gibson, Dunn and Crutcher stated that the review of evidence published with the guidelines

> contradicts OSHA's ergonomic hypothesis that work causes physical injury, contradicts OSHA's view that ''ergonomic'' interventions can alleviate workplace pain, and contradicts

OSHA's prescription for rest as a response to back pain. [Ex. 500–118]

OSHA disagrees with these commenters. In reviewing the record, OSHA finds that the final rule is consistent with the medical literature, including the AHCPR guidelines, the American College of Occupational and Environmental Medicine (ACOEM) Occupational Medicine Practice Guidelines (Ex. 38–234), The Royal College of General Practitioners' Clinical Guidelines for the Management of Acute Low Back Pain (Royal College guidelines) (Waddell *et al.* 1999; Ex. 32-241–3–38), the Faculty of Occupational Medicine's Occupational Health Guidelines for the Management of Low Back Pain at Work (British guidelines) (Ex. 500–118–2), and other evidence-based medical practice.

The first assertion, that the AHCPR guidelines ''contradict[ ] OSHA's ergonomic hypothesis that work causes physical injury'' is incorrect for several reasons. The AHCPR guidelines acknowledge that

> * * * several studies have identified an increased incidence of low back problems among individuals whose work involves heavy or repetitive lifting, exposure to total body vibration (from vehicles or industrial machinery), asymmetric postures, and postures sustained for long periods of time. [Ex. 32–241–3–93]

The guidelines also recognize that

> Other biomechanical research suggests that certain postures and activities increase the mechanical stress on the spine. It is not clear whether these mechanical stresses are the cause of low back problems. However, once symptoms are present, mechanical stresses correlate with worsening of symptoms. Prolonged sitting and postures that involve bending and twisting have been shown to increase the mechanical stress on the spine according to pressure measurements in lumbar intervertebral discs. Heavy lifting also appears to increase mechanical stress on the spine, but this stress can be reduced if the lifted object is held close to the body rather than at arm's length. [Ex. 32–241–3–93]

These conclusions are clearly consistent with the conclusions of the Health Effects section of the final rule that biomechanical factors are associated with low back pain. It must be recalled that the AHCPR guidelines were

> * * * intended to provide primary care clinicians with information and recommended strategies for the assessment and treatment of acute low back problems in adults. [Ex. 32–241–3–93]

They were not intended to provide a comprehensive review of work-related low back pain, ergonomics or low back pain prevention. There are few references to ergonomics, and the guidelines promotes the utility of ergonomics in return to work decision making by stating that: ''Several ergonomic guidelines on lifting and materials-handling tasks are available to help the clinician provide ranges of activity alterations at work.'' (Ex. 32–241–3–93)

Finally, the AHCPR guidelines (Ex. 32–241–3–93) do not suggest that patients with acute low back pain immediately return to work involving physical factors that may stress the spine. Rather they advise appropriate activity modification to assist in the recovery process. AHCPR guidelines Activity Recommendations panel findings and recommendations state: (1) ''Patients with acute low back problems may be more comfortable if they temporarily limit or avoid specific activities known to increase mechanical stress on the spine, especially prolonged unsupported sitting, heavy lifting, and bending or twisting the back while lifting. (Strength of Evidence = D.);'' and (2) ''Activity recommendations for the employed patient with acute low back symptoms need to consider the patient's age and general health, and the physical demands of required job tasks. (Strength of Evidence = D.)'' As to the duration of activity modification, the AHCPR guidelines demonstrate an understanding of the impact that the physical demands of work have on recovery and modified activity. The guidelines state that ''The nature and duration of limitations will depend on the clinical status of the patient and the physical requirements of the job.''

Several other components of the final rule are supported by AHCPR recommendations, including the use of job hazard analysis and medical management involving communication with the HCP. Pertinent AHCPR guidelines statements are as follows: (1) ''In recommending activity modifications for patients who work, the clinician may find it helpful to obtain from the employer a description of the physical demands of required job tasks,'' and (2) ''The panel recommends that clinicians help patients establish activity goals, in consultation with their employer when applicable.''

As with the AHCPR guidelines (Ex. 32–241–3–93), the commenters cited above did not accurately represent the findings of the Royal College guidelines (Ex. 32–241–3–38) and British guidelines (Ex. 500–118–2) in criticizing OSHA's proposal. They also failed to acknowledge evidence and recommendations from these reports that are consistent with the final rule.

The Royal College guidelines (Ex. 32–241–3–38) were developed for the purpose of disseminating evidence-based recommendations on the management of acute low back pain to clinicians. The Royal College guidelines do not purport to relate to, nor were they focused on, the same purpose as OSHA's proposal, that is to reduce MSDs and control MSD hazards in the workplace. These guidelines do not contain information on evidence based conclusions on ergonomics or low back pain prevention. Several elements of the proposal are supported by the Royal College guidelines (Ex. 32–241–3–38). For example, under Initial Assessment Methods, they recommend: ''The patient's age, the duration and description of symptoms, the impact of symptoms on activity and work, and the response to previous therapy are important in the care of back problems.'' Under Information to Patients, the guidelines state: ''About 10% of patients will have some persisting symptoms a year later, but most of them can manage to continue with most normal activities. Patients who return to normal activities feel healthier, use less analgesics and are less distressed than those who limit their activities.'' The Royal College guidelines suggest that most workers can manage with most normal activities, but do not suggest that this includes extremely physical tasks that cause very significant mechanical loading to the lumbar spine and are associated with elevated risks of low back pain.

Similarly, the purpose and findings of the British occupational health low back pain guidelines (Ex. 500–118–2) have also been misrepresented (*e.g.*, Ex. 32–241–3–20). The British guidelines state: ''These guidelines represent the main recommendations and evidence statements derived from a detailed Evidence Review and developed by a multidisciplinary group of practitioners. They concern the clinical management of workers affected by non-specific low back pain, including advice on placement, rehabilitation and measures for prevention.'' The British guidelines further clarify that they were not intended to disseminate information regarding workplace health and safety, job design, and ergonomics when they state: ''They focus on actions to be taken to assist the individual and do not specifically cover legal issues, health and safety management, job design and ergonomics.'' Again, this is a different focus than the proposal, and conclusions should be interpreted in that light. Under evidence review methods, the British guidelines state:

> In view of the occupational health focus of the guidelines and the present review, the following areas were excluded from the review, except where they impact directly on the guideline recommendations: chronic

intractable pain, long-term disability and pain management programmes; spinal surgery and post-operative states; primary ergonomic interventions. [Ex. 32–241–3–93]

The British guidelines (Ex. 500–118–2) acknowledge the role of work in contributing to low back pain in its own preface. In reviewing challenges for the review the authors state: ''The need for everyone to recognize that work is only one contributor to back pain but that back pain whatever its cause can, if poorly managed, have a devastating effect on a person's ability to work.'' The review goes on to classify evidence based literature recommendations using the following classification scenarios:

****Strong evidence*—provided by generally consistent findings in multiple, high quality scientific studies.

***Moderate evidence*—provided by generally consistent findings in fewer, smaller or lower quality scientific studies.

**Limited or contradictory evidence*—provided by one scientific study or inconsistent findings in multiple scientific studies.

—*No scientific evidence*—based on clinical studies, theoretical considerations and/or clinical consensus.

Several British guidelines (Ex. 500–118–2) findings are consistent with the final rule. With respect to the relationship of physical work factors and work-related low back pain, the guidelines report the following evidence based findings: There is strong evidence that

Physical demands of work (manual materials handling, lifting, bending, twisting, and whole body vibration) can be associated with increased reports of back symptoms, aggravation of symptoms and ''injuries.'' [Ex. 500–118–2]

These guidelines therefore acknowledge potential for physical work factors to precipitate low back pain episodes, and recognize some evidence of a cumulative effect of spinal loading. In addition, management of work-related low back pain, as noted in the AHCPR low back pain guidelines, may reasonably include elements similar to those in the OSHA final rule, such as

* * * temporarily limit[ing] or avoid[ing] specific activities known to increase mechanical stress on the spine, especially prolonged unsupported sitting, heavy lifting, and bending or twisting the back while lifting. [Ex. 32–241–3–93]

In summary, the British guidelines (Ex. 500–118–2) state that there is moderate evidence that ''From an organisational perspective, the temporary provision of lighter or modified duties facilitates return to work and reduces time off work.''

The British guidelines (Ex. 500–118–2) go on to cite other conclusions about work and low back pain using evidence based literature reviews (Evidence) and consensus opinion (Recommendation). In making recommendations on prevention and case management, the authors advise the ''need to be directed at both physical and psychosocial factors.'' If physical work is not harmful and it does not contribute to low back pain, then why would the authors advise addressing the physical task factors of work in prevention efforts? Similarly, if physical characteristics of work are not significant issues for workers who return to work after developing a low back disorder, then why do the authors state the following?

There is a pragmatic argument that individuals at highest risk of LBP should not be placed in jobs that impose the greatest physical demands. The basic concern is that workers with physically (or psychologically) demanding work report rather more low back symptoms, have more work-related back ''injuries'' and lose more time off work with LBP. Even if physical demands of work may be a relatively modest factor in the primary causation of LBP (see Background above), people who have LBP (for whatever cause) do have more difficulty managing physically demanding work (T3: (Muller *et al.*1999) T2: (Waddell 1998)). It may be argued, therefore, that avoiding putting people at highest risk of recurrent LBP and sickness absence into more physically demanding work would be in the interests of the individual worker, the employer and the total societal burden of LBP. [Ex. 500–118–2]

Similarly, the ACOEM guidelines (Ex. 38–234) agree with the observation that specific physical work factors are associated with certain work-related MSDs.

One of the criticisms raised by a commenter was the limited reference to the Cochrane Collaboration Back Review Group in low back sections of the Health Effects section of the preamble to the proposed rule. However, as a significant contributor to this effort, Dr. Nachemson clarified that neither work-related back pain nor ergonomics were the focus of these reviews (Tr. 6779).

Although Dr. Nachemson questioned OSHA's findings of the relationship of work to the development of work-related low back disorders, he contradicts this in the chapter he authored for the International Society for the Study of the Lumbar Spine, entitled ''Future of Low Back Pain'' (Wiesel *et al.* 1996, Ex. 26–1620). The chapter has a table compiled on the effects of external load on low back structures. The table lists extreme loading activity, several hours of hard training, extreme body position, as having negative influences on muscle, cartilage, and disc.

Dr. Stanley Bigos admitted that physical work factors could result in the development of low back pain in an exchange with one of the questioners.

MS. GWYNN: Doctor, you believe, do you not, that lifting and bending while lifting and twisting while lifting can aggravate low back pain?

DR. BIGOS: I believe that it can bring on symptoms in people who have had prior back problems. And perhaps, it could bring on symptoms of people who haven't, depending upon the condition they are in. [Tr. 6916]

Along other lines, some commenters raised issues with OSHA's inclusion of symptoms in the definition of an MSD. Gibson, Dunn and Crutcher stated that:

These sensations that the agency treats as tantamount to musculoskeletal injury are ubiquitous in the general population and do not warrant interference by the agency. [Ex. 500–118]

OSHA does not agree with this argument. OSHA is not attempting to regulate common symptoms. Rather, OSHA has proposed strategies to modify physical workplace factors that are associated with the development of MSDs, when the physical factors at work are present in frequency, intensity, and/or duration likely to be responsible for causing observed MSDs. As required in the final rule, the employer's responsibility is that it must evaluate employee reports of MSD signs and symptoms to determine whether an MSD incident has occurred. The evaluation may include an evaluation by an HCP to determine the nature of the condition and assist the employer in evaluating the work-relatedness of the MSD. Many employers presently act in a very similar manner when an employee reports a potential problem. The employer may perform an accident or incident investigation, offer temporary modified duty, correct the problem, and/or refer the employee to a HCP for evaluation.

Gibson, Dunn, and Crutcher also suggested that paying attention to subjective complaints would lead to inaccurate diagnoses. They state that:

One of the challenges presented by MSDs is that, in order to diagnose an affliction (in an effort to determine what response is required to comply with the proposed standard), an employer or the employer's physician must rely principally, if not solely, on subjective reports of pain from employees. [Ex. 500–118]

These assertions are incorrect, and are not consistent with medical literature and opinion. A worker's medical history, including subjective reports like pain, is a key element that has been utilized since the beginnings of medicine to help physicians diagnose medical conditions. The AHCPR guidelines emphasize the role of the medical history when they state:

A few key questions on the medical history can help ensure that a serious underlying condition, such as cancer or spinal infection, will not be missed * * * Symptoms of sciatica (leg pain) or neurogenic claudication (walking limitations due to leg pain) suggest possible neurologic involvement. Pain radiating below the knee is more likely to indicate a true radiculopathy than pain radiating only to the posterior thigh. A history of persistent numbness or weakness in the leg(s) further increases the likelihood of neurologic involvement. The articles indicate that cauda equina syndrome can be ruled out with a medical history that ascertains the absence of bladder dysfunction (usually urinary retention or overflow incontinence), saddle anesthesia, and unilateral or bilateral leg pain and weakness. [Ex. 32–241–3–93]

The AHCPR guidelines go on to clarify that the examination is used to confirm clinical impressions derived from the medical history, including pain characteristics:

The physical examination supplements the information obtained in the medical history in seeking an underlying serious condition or possible neurologic compromise. [Ex. 32–241–3–93]

The AHCPR low back pain guidelines also indicate that ''The physical examination is less useful than the history in searching for underlying serious conditions.'' Thus OSHA's approach to the use of employee symptoms is similar to the AHCPR rigorous analysis of the literature on acute low back pain evaluation and treatment that concluded that symptoms and history give important information to diagnose and manage adults with acute low back pain.

Both the Royal College and British guidelines support the role of history, including symptoms, in the diagnosis and management of low back pain. The British guidelines state:

The patient's age, the duration and description of symptoms, the impact of symptoms on activity and work, and the response to previous therapy are important in the care of back problems. (B: Moderate research based evidence). [Ex. 500–118–2]

The guidelines confirm AHCPR recommendations by indicating:

The initial clinical history can identify 'red flags' of possible serious pathology. Such inquiries are especially important in patients over age 55. (B: Moderate research based evidence). [Ex. 500–118–2]

OSHA's approach, in particular the acknowledgment of worker symptoms, parallels this literature based analysis.

Further validation of the importance of symptom reporting for low back pain comes from the ACOEM guidelines (Harris *et al.* 1997; Ex. 502–240). The ACOEM guidelines included peer review by Dr. Stanley Bigos, expert witness for UPS and Anheuser-Busch and others. The following quotes are excerpted from the guidelines:

A focused medical history, work history, and physical examination are generally sufficient to assess the worker with a complaint of an apparently job related disorder. [Ex. 502–240]

In this assessment, certain patient responses and findings raise the suspicion of serious underlying medical conditions.

The patient's description of the mechanism of injury (so far as is known), his or her presenting symptoms, the duration of symptoms, exacerbating factors, and the history of previous episodes will help define the problem. [Ex. 502–240]

In Chapter 14, the ACOEM guidelines state:

Thorough medical and work histories and a focused physical examination are sufficient for the initial assessment of the worker with a complaint of potentially work-related low back symptoms. [Ex. 502–240]

These statements from clinical medicine practice guidelines provide further support for the use of symptoms as a trigger in the final rule. The practice guidelines make use of the patient history and reports of symptoms and take a consistent approach to the physical examination referent to patients with low back pain.

This approach is consistent with the one medical text brought to OSHA's attention. The International Society for the Study of The Lumbar Spine publishes a text entitled ''The Lumbar Spine'' (Wiesel, *et al.* 1996; Ex. 26–1620). In Chapter 3 on clinical evaluation of low back pain by Jeremy Fairbank and Hamilton Hall (History taking and physical examination: Identification of syndromes of back pain), the authors state:

Conventional western medical therapy is practiced on the basis of a diagnosis that is made from a synthesis of information acquired from the patient's history, physical examination, and special investigations. Back pain is a common presenting symptom, and its diagnosis should be approached in the same manner as that of any other symptom. [Ex. 26–1620]

They further state that

A detailed history obtained from the patient is essential for making a diagnosis, assessing disability, and dictating management. Time spent listening to the patient is not wasted. Back pain has a wide variety of causes, and many of these can be revealed during history taking. [Ex. 26–1620]

providing support that

Objective evidence obtained on physical examination should enhance and support the diagnostic hypotheses arising from the patient's history. [Ex. 26–1620]

The authors go on to propose a classification system for low back pain (Pynsent-Fairbank-Hall Classification of Extraspinal Pain), which is primarily based upon patient symptoms. The acknowledgment of the importance of symptoms in this text is of particular interest to OSHA due to the fact that two principal expert witnesses who testified on behalf of UPS and others that symptoms are not meaningful, Dr. Stanley Bigos and Dr. Alf Nachemson, are members of The International Society for the Study of The Lumbar Spine, the organization that published the above text.

The classification of low back pain primarily upon patient symptoms is similar to the approach used by the Quebec Task Force (1987; Ex. 26–494). Dr. Nachemson also served as a member of the task force for this publication. The Quebec classification included 11 categories, with 1–4, 8, 9 and 10 based upon symptoms.

The American Medical Association, in its Guides to the Evaluation of Permanent Impairment, 4th edition, (Ex. 38–246) also include symptoms in classifying impairment. In particular, Table 72 in that publication contains a Diagnosis Related Estimate for Lumbosacral Category II: Minor Impairment (5% whole person impairment). The guidance used by the AMA for this is ''The clinical history and examination findings are compatible with a specific injury or illness. The findings include significant intermittent or continuous muscle guarding that has been observed and documented by a physician, nonuniform loss of range of motion, or nonverifiable radicular complaints. There is no objective sign of radiculopathy and no loss of structural integrity.'' There is similar guidance for the cervical spine.

Guidelines for diagnosis and treatment of low back pain that have been published in the United States include the AHCPR guidelines (Ex. 32–241–3–93) and the ACOEM guidelines (Ex. 38–234). These will be addressed in the discussion on rest and activity to follow in this section.

It must also be recognized that low back pain is not the only potentially covered MSD, and other potential MSDs may present as symptoms only. For example, it is clear that patients with CTS may have symptoms of numbness without any physical findings (Erdil and

Dickerson 1997, Ex. 502–18; Katz *et al.* 1991, Ex. 38–101; Moore 1992, Ex. 26–985). Of significance, commonly utilized physical signs to clinically diagnose carpal tunnel syndrome, such as the Tinel's test and Phalen's sign, do not have as high a sensitivity or specificity as the Hand Diagram (Katz and Stirrat 1990; Ex. 500–121–33), a symptom based tool. Clearly, utilizing symptoms to identify possible cases of carpal tunnel syndrome and other MSDs is consistent with the knowledge based upon reviewing the medical literature.

Dr. Malcolm Jayson argued that

> * * * if a person has pain in the knee, the most effective form of treatment is knee exercises. When we rehabilitate back problems we prescribe[] exercises with a progressive regime to increase physical capacity. There is now overwhelming evidence that exercise is good for back problems and damaged joints and rest is harmful. [Ex. 32–241–3–9]

However, nowhere does OSHA state that all exercise is harmful, nor does it support rest as the treatment for MSDs. With regard to work factors like repetition, it is important to recognize that biomechanical factors that are present in a sufficient intensity, duration, and/or frequency to cause or contribute to an MSD are addressed. In these circumstances, OSHA recommends modification of exposure to these factors. It is clear that, when excessive, repetition and other cited work factors can cause MSDs. Several studies were presented in the Health Effects Section of the final rule to demonstrate the pathogenic mechanisms through which physical work factors can be responsible for causing or contributing to certain MSDs identified in the epidemiologic review. Unfairly, this statement simplifies physical factors in work settings as solely characterized by repetition, without considering the frequency, duration, and periodicity of the repetitive activities. In addition, it ignores other factors that have potential to cause MSDs in the workplace, such as excessive force, awkward posture, contact stress, and vibration. Also neglected is the observation that combinations of factors like force, posture, etc. with repetition, may compound the effect of repetition on musculoskeletal tissues. Finally, the statement does not differentiate types of tissue affected and whether the tissue is healthy or damaged.

In the preface to The American Academy of Orthopedic Surgeons' book entitled ''Repetitive Motion Disorders of the Upper Extremity'' (Gordon *et al.* 1995; Ex. 26–1399), the editor states:

> There is overwhelming evidence that the number of reported cases of repetitive motion disorders is rapidly growing. These disorders have become an extremely costly public health issue. Although some individuals believe that the underlying issue may be improper reporting or false claims of a medical problem, the organizers and most of the participants believe that for the vast majority of cases, there is an underlying physiologic insult to one or more of the various tissues involved.

The text goes on to cover epidemiologic evidence; pathophysiology of biomechanical loads, connective tissue, muscle and nerve. Chapters on rehabilitation of the wrist, elbow and shoulder all indicate that time limited periods of rest may be indicated for acute MSDs. The book is the result of a workshop organized by the National Institute of Arthritis and Musculoskeletal and Skin Disease, NIH. Co-sponsors included NIOSH, CDC, Orthopedic Research and Education Foundation, the National Center for Medical Rehabilitation Research, and others. One expert witness Dr. Stanley Bigos, who testified on behalf of one industry group organized in opposition to OSHA's proposed standard in general, is a member of AAOS.

In June 1998, Clinical Orthopedics and Related Research (Exs. 26–1310, 26–1322, 26-1316) covered Cumulative Trauma Disorders of the Upper Extremity through a joint sponsorship of the Association of Bone and Joint Surgeons, the Academic Orthopedic Society, the Hip Society, the Musculoskeletal Tumor Society, and the Knee Society. This text again covered sections regarding the effects of physical work factors (*i.e.* repetition) on nerve, muscle, joints, and certain clinical conditions.

Similarly, the National Academy of Sciences, in 1999, (Ex. 26–37) published the results of a workshop they sponsored on work-related MSDs. While there was some variance in opinions about the contribution of physical work factors to MSDs, there was agreement among most that physical work factors contribute to MSDs. ''MSDs are multifactorial, with work and biomechanical aspects of work being important contributors.'' The NAS reviewers also explained the concepts behind temporary rest or activity modification for injured tissues.

Contrary to the view of NAS, Dr. Stanley Bigos provided the following comment:

> Contrary to ergonomists' beliefs, usage is a prerequisite to health—using the body, even vigorously using the body, is not intrinsically harmful. That is why repetitive motion that fatigues musculoskeletal tissues is medically prescribed, to the point of being the preferred method of treatment even of tissues that have sustained traumatic injury or age-related degeneration. Properly conditioned; a traumatically injured joint may be restored to full function by the protection of muscles stronger than before the injury. [Ex. 32–241–3–4]

Dr. Bigos' statement that ''repetitive motion that fatigues musculoskeletal tissues is medically prescribed, to the point of being the preferred method of treatment even of tissues that have sustained traumatic injury or age-related degeneration,'' while having elements of validity, again fails to look at the various work-related MSDs as well as the stage and severity of the condition. There is supporting literature and consensus, including clinical practice guidelines (*e.g.* ACOEM; Ex. 38–234) that recommend periods of splinting and rest for MSDs like acute tendonitis or stenosing tenosynovitis, DeQuervain's disease and carpal and cubital tunnel syndromes. A comparison could be made to a patient who experiences an acute myocardial infarction with muscle damage. In this scenario, rehabilitation often includes carefully controlled exercise appropriate to the stage of recovery and level of function of the remaining heart muscle. It would not be reasonable to presume that a patient one day after a significant myocardial would be improved if forced to run a marathon. Neither would a worker benefit from intensive and uncontrolled exercise after the onset of an acute MSD with significant inflammation, degeneration and loss of function.

The same commenters stated that OSHA's use of the term ''rest'' in the proposal implied that OSHA recommends or promotes bed rest for workers with MSDs. This statement is incorrect and fails to recognize the purpose and application of the standard. This standard is not intended as a guideline for the medical treatment of MSDs. Medical treatment is left to the licensed health care provider, utilizing sound medical judgement, and evidence based literature and clinical practice guidelines.

What OSHA did intend when it used the term ''rest'' was appropriate activity modification. The standard supports return to work where there are effective controls of biomechanical factors causing or contributing to the MSD. The preamble to the proposal stated:

> Although some covered MSDs are at such an advanced state that complete removal from the work environment is the appropriate treatment, it should usually be the recommendation of last resort. Where appropriate, work restrictions that allow the employee to continue working (*e.g.,* in an

alternate job, or by modifying certain tasks in the employee's job to enable the employee to remain in that job) are preferable during the recovery period.

Dr. Stanley Bigos argued that the proposed ergonomics rule was at odds with the recommendations of the AHCPR guidelines, in that the proposed rule recommended rest, reduced work, and inactivity in response to pain, while the AHCPR guidelines recommend increased activity and conditioning (Ex. 32–241–4).

The AHCPR guidelines (Ex. 32–241–3–93) do recommend that adults with acute low back pain maintain activity. However, the guidelines do not suggest that patients with acute low back pain immediately return to work involving physical task factors that may stress the spine. Rather they advise appropriate activity modification to assist in the recovery process. AHCPR guidelines Activity Recommendations panel findings and recommendations state: ''Patients with acute low back problems may be more comfortable if they temporarily limit or avoid specific activities known to increase mechanical stress on the spine, especially prolonged unsupported sitting, heavy lifting, and bending or twisting the back while lifting. (Strength of Evidence = D.);'' and, ''Activity recommendations for the employed patient with acute low back symptoms need to consider the patient's age and general health, and the physical demands of required job tasks. (Strength of Evidence=D.)''

The AHCPR guidelines acknowledge that

> several studies have identified an increased incidence of low back problems among individuals whose work involves heavy or repetitive lifting, exposure to total body vibration (from vehicles or industrial machinery), asymmetric postures, and postures sustained for long periods of time.'' [Ex. 32–241–3–93]

The guidelines also recognized that

> Other biomechanical research suggests that certain postures and activities increase the mechanical stress on the spine. It is not clear whether these mechanical stresses are the cause of low back problems. However, once symptoms are present, mechanical stresses correlate with worsening of symptoms. Prolonged sitting and postures that involve bending and twisting have been shown to increase the mechanical stress on the spine according to pressure measurements in lumbar intervertebral discs. Heavy lifting also appears to increase mechanical stress on the spine, but this stress can be reduced if the lifted object is held close to the body rather than at arm's length.'' [Ex. 32–241–3–93]

As to the duration of activity modification, the AHCPR guidelines (Ex. 32–241–3–93) demonstrate an understanding of the impact that the physical demands of work have on recovery and modified activity. They state that ''The nature and duration of limitations will depend on the clinical status of the patient and the physical requirements of the job.''

While the AHCPR guidelines (Ex. 32–241–3–93) did not find evidence that bed rest was beneficial for the majority of individuals with acute low back pain, the panel did acknowledge that, in some circumstances, bed rest may be required for select patients with acute low back pain (''The majority of low back patients will not require bed rest. Bed rest for 2 to 4 days may be an option for patients with severe initial symptoms of primarily leg pain.'')

Program elements in OSHA's proposal are also consistent with the British guidelines, that state that there is moderate evidence that

> From an organisational perspective, the temporary provision of lighter or modified duties facilitates return to work and reduces time off work. [Ex. 500–118–2]

Some commenters appeared to confuse the concepts relevant to the practice of sports medicine with concepts relevant to the prevention of MSDS in workers. For example, Gibson, Dunn & Crutcher state

> Increase in physical activity (compared to past activity level) is a guiding principle in musculoskeletal rehabilitation, and has been the primary intervention and treatment in many musculoskeletal disorders. These treatment protocols include many of the physical stresses that OSHA recommends avoiding. [Ex. 500–118]

This again is an overly simplistic statement, since there are differences in the intensity, duration, and/or frequency of guided rehabilitation of an injury that is tailored to the individual's type of injury, severity of the condition, stage of rehabilitation and the individual's conditioning, as opposed to intensity, duration, and/or frequency of physical job factors that are based upon delivery of goods or services and have no bearing upon individual capabilities or injuries. Dr. Tapio Videman, another expert witness for the UPS attempted to explain the importance of physical activity as follows:

> Sports medicine—and much of modem mainstream medicine—views physical loading as a means of increasing fitness, strength, and function, and is part of most related intervention today. Why would physical loading be harmful in work but beneficial in leisure time? * * * Physical activity can promote physical adaptation to loading, and restore and maintain functional capacity. This may explain why there is some evidence of the benefits of exercise for spinal disorders. [32–241–30–20]

However, comparisons of workers with young and highly skilled athletes is not appropriate. This is pointed out by the ISSLS text on the Lumbar Spine (Wiesel *et al.*1996; Ex. 26–1620). The following quote is from the chapter on biomechanics:

> Comparison of athletic exercises with industrial labor is complicated because, in the athletic field, (1) one deals with young, healthy subjects; (2) there is a selection of individuals for the specific tasks; (3) the specific task is always accompanied by remedial exercises. In industrial labor, one is dealing with the average population. There is almost no selection of the individuals, and there are many monotonous tasks that are not interrupted by remedial exercise. [Ex. 26–1620]

Dr. Michael Vender explained his belief that soft tissue has almost limitless capacity to recover from injury.

> We cannot explain the natural process of aging and gradual deterioration of all body parts by the concept of cumulative trauma. The most basic flaw in this logic revolves around the comparison of the human body to a piece of metal [as reflected in the biomechanical model espoused by ergonomists). [Unlike metal], the body, when stressed or even injured, has the ability to heal and recover.—When one repeatedly bends a piece of plastic, it becomes permanently deformed. When one repeatedly exercises a muscle, it becomes stronger and more functional. [Ex. 32–241–3–19]

This belief is in contrast to the opinion of the NAS workshop (1999) (Ex. 26–37) noted above, and fails to recognize concepts of muscle disruption, tendon and ligament viscoelastic deformation and creep discussed in the Health Effects Preamble.

7. Additional Criticisms of Epidemiological Studies Raised by Commenters

Gibson, Dunn & Crutcher in their post-hearing comments (Ex. 500–118, Section B, pgs. 65–81) supply critiques of additional ''studies on which OSHA relies or may rely in support of the proposed rule.'' (*id.,* pg. 65). OSHA's response to these critiques is given below.

Gibson Dunn & Crutcher criticize the study by Latza *et al.* (2000, Ex. 38–424) that examined occupational risk factors of low back pain among construction workers. Among their criticisms, Gibson Dunn & Crutcher argue that the authors drew causal inferences from a study that is only an exploratory analysis. Further, they claim that the researchers were vague in their methods and did not come up with a single promising association.

OSHA disagrees with these criticisms. First, the study as a whole cannot be fairly characterized as an ''exploratory analysis.'' This study is an adequately designed longitudinal epidemiological study where construction workers who reported no low back pain at baseline were followed for three years. The ''exploratory approach'' reported by the authors refers not to the study as a whole but rather to a detailed analysis of the data to identify potential risk factors that might be used to predict low back pain. The authors describe a detailed process for focusing on factors most likely to have caused the observed reports of low back pain. Second, OSHA disagrees that the authors were vague in their methods. Various aspects of the study, such as the selection of study subjects, data collection, and data analysis, were described in clear enough detail that would allow the reader to assess the results reported. Finally, the authors noted that causality cannot be established with this study. However, the purpose of the study was to identify possible risk factors for low back pain among these workers that might aid in the identification of hazardous components in the work that can guide effective primary intervention. In this regard, the authors report positive associations that show that certain occupational risk factors can be predictive of low back pain.

Gibson, Dunn & Crutcher criticize a study by Punnett *et al.* ''A comparison of Approaches to Modeling the Relationship between Ergonomic Exposures and Upper Extremity Disorders'' (2000, Ex. 500–71–43). This is a methodology study concerning approaches for combining independent and dependent variables for the purpose of exposure-response analysis. This study uses the information on upper extremity disorders in vehicle manufacturing found in an earlier Punnett *et al.* (1998, Ex. 26–38) study), which these same commenters criticized previously (Ex. 32–241–4, pg. 144). OSHA has responded to those criticisms elsewhere in this preamble.

Gibson, Dunn & Crutcher have two main criticisms of the Kurppa *et al.,* (1991, Ex. 26–53) study concerning the incidence of tenosynovitis or peritendinitis and epicondylitis in a meat-processing factory. The commenters claim that the diagnostic definition of the response tenosynovitis or peritendinitis (agreed to by the plant physician), ''boils down to focal soreness/tenderness and nothing more specific or mysterious than that.'' (Ex. 500–118, pg. 71). In response, OSHA notes that, in order to be included as a response in the study, the condition needed to be severe enough in each case to qualify for sick leave (Ex. 26–53, pg. 33). As a result, OSHA believes that the response is a meaningful health effect, *i.e.*, because it was serious enough to warrant time away from work for recuperation. Gibson, Dunn & Crutcher (Ex. 500–118 pg 71) also claim that, ''By its very nature, a surveillance study perturbs the experience of discomfort.'' However, this type of physiological biasing factor would appear to have only a minimal or no effect on the end results since the rate of occurrence of tenosynovitis or peritendinitis and epicondylitis, for both men and women, was shown typically to be an order of magnitude higher for strenuous compared to non-strenuous meat processing jobs (Ex. 26–53, pg. 34).

Gibson Dunn & Crutcher correctly point out (Ex. 500–118, pg. 72–73) that the utility of participatory ergonomics was not evaluated in the Roquelaure *et al.* (1997, Ex. 38–96) study. However, OSHA used this study only to show an association between stress variables and carpal tunnel syndrome (CTS). The role of participatory ergonomics in reducing CTS was not alluded to by OSHA.

Gibson Dunn & Crutcher correctly point out (Ex. 500–118, pg. 73) that in the Viikari-Juntura *et al.* (1994, Ex. 26–873) study what is defined as severity of neck trouble is in fact the frequency of self-reported symptoms (pain, ache, stiffness or numbness). As a result, Gibson Dunn & Crutcher believe the possibility exists that the subject's statements concerning severe neck trouble could be misleading. OSHA used the Viikari-Juntura *et al.* study to only show an association between neck symptoms and stress factors. OSHA did not comment on the severity of the symptoms.

Gibson Dunn & Crutcher note (Ex. 500–118, pgs. 73–74) that the authors of the Kearns *et al.* (2000, Ex. 500–71–34) study did not intend that the results of the study on the prolongation of median motor and sensory nerve latency be generalized beyond the effects of work related to pork processing. OSHA agrees that the study supplies limited information about the relationship between workplace physical factors and CTS.

Stenlund et al.studies, Exs. 26–733 and 26–1479

Gibson Dunn & Crutcher (Ex. 500–118 pg. 70–71) have criticized the 1992 study by Stenlund *et al.* (Ex. 26–733) of osteoarthrosis and the 1993 Stenlund *et al.* (Ex. 26–1459) of shoulder tendinitis. First, the 1992 Stenlund *et al.* study is criticized for its conclusion that radiographic evidence of osteophytes (spurs) in the acromioclavicular joint is a predictor of osteoarthrosis causing cartilage loss and abnormal reparative processes. Gibson Dunn & Crutcher argue that in other joints, such as the knee, increased usage leads to osteophytosis (spurs) and increased preservation of cartilage, which is good. They question whether the Stenlund *et al.* (1992) paper is detecting a ''bad'' outcome. Gibson Dunn & Crutcher also criticize the 1993 Stenlund *et al.* paper for using shoulder tendinitis as an adverse effect measure, arguing that shoulder tendinitis is subject to overt reporting and recording bias. They conclude that these types of outcome measures are not appropriate to be used in epidemiological studies.

With regard to the 1992 Stenlund *et al.* study, the critics are comparing minimal changes commonly observed with habitual usage of a joint such as the knee (*e.g.*, increased preservation of cartilage) to severe osteoarthrosis, from heavy manual work and vibration, of a joint, in this case the shoulder. In the Stenlund study, radiographs were classified into 5 grades of osteoarthrosis (0 = normal; 1= minimal changes; 2 = moderate changes, more severe changes to cartilage and bone structure begins to be affected; 3 = severe osteoarthrosis, and 4 = totally destroyed joint). Those classifying the radiographs were blinded as to exposure. The authors did not find significant differences in lower grade changes. However, they did observe that among rock blasters and bricklayers who had exposure to heavy load and vibration compared to foremen who did not, there was a significant increase in grade 2 and 3 osteoarthrosis. Therefore, OSHA believes that Gibson Dunn & Crutcher are actually confusing two different health outcomes in their criticism. The study by Stenlund *et al.* (1992) would support the hypothesis that normal habitual use of the shoulder might cause increased preservation of the cartilage. However, shoulder joints exposed to heavy loads and vibrations such as those examined in the study show radiographic evidence of severe osteoarthrosis.

With regard to the 1993 Stenlund *et al.* study, the authors noted the potential for misclassification when using tendinitis as a measure of outcome. They agree that in some epidemiological studies, clinical diagnosis of tendinitis may not be an appropriate measure of prevalence in the population, since some individuals with tendinitis may not see a physician for their symptoms, thus creating a selection bias. However, the authors assert that this type of bias is overcome in their study by the use of a cross sectional study design. In order to further lessen the potential for misclassification, the authors also included symptoms of pain during the last year that could have originated from structures other than the tendons or muscle attachment inflamation in addition to using palpation and isometric contraction. They reasoned that persons experiencing pain in their shoulder in the last year and who on examination have pronounced pain reaction to palpation and contraction, have probably had a disorder in the muscle attachment or tendon, that in clinical practice would have been classified as tendinitis. OSHA believes that, with proper study design and control for misclassification, as was done in the Stenlund study, clinically diagnosed shoulder tendinitis is an adequate measure of effect. Thus, the Stenlund *et al.*, 1993 study can be used with other studies in the record to form a reliable weight of evidence on which to base the agency's health effects conclusions.

Gibson Dunn & Crutcher also criticized the 1990 study on degenerative disc disease among concrete workers and house painters by Riihimaki *et al.* (Ex. 502–455). They argue that the results of this study are ''not compelling'' because the authors found insignificant risk ratios and, thus, are very likely to be influenced by unmeasured variables. OSHA finds this argument unconvincing for the following reasons. Number one, the authors did, in fact, find a statistically significant risk of detectable degenerative changes in the lumbar spine among concrete workers (38%) compared to house painters (26%). (Relative Risk=1.4, (CI 1.1–1.8; p<0.01)) In this study, concrete reinforcement workers were compared to house painters. The authors noted that the load on the back is distinctly different among concrete workers compared to house painters. The authors also note that in Finland, persons in these trades have very similar socio-economic status and lifestyles, thus making it more likely that the detected difference between these groups is due to occupational exposures rather than other factors. Moreover, as a part of the study design the concrete reinforcement workers and house painters were matched by age, earlier back accidents, height, body mass index and smoking. These covariates were included in a mutivariate logistic regression to perform the statistical analysis to control for possible confounding factors likely to affect disc degeneration. After controlling for these factors, the authors still reported statistically significant effects. In addition, the authors noted that workers, to be included in the study, had to have at least 5 years seniority, thus creating the possibility for negative bias due to health-based self-selection of workers in the more physically demanding job (*i.e.* concrete workers). The effect of this negative bias, however, would underestimate the risk ratios. In an attempt to understand the underlying etiology of this disc degeneration, the authors did additional analyses looking at different segments of the lumbar region and different degenerative spinal changes (*e.g.* disc space narrowing, spondylophytes, and endplate sclerosis). In some of these sub-analyses for certain lumbar regions, there was no statistically significant effect. Overall, however, the authors found a significant association between work and disc degeneration while controlling for confounders. Therefore, OSHA does find these results compelling and generally supportive of its health effects assessment.

Gibson Dunn & Crutcher criticized the 1994 study of sciatic pain among men in machine operating, dynamic physical work and sedentary work by Riihimaki *et al.* (1994, Ex. 26–1188). They claim that the associations observed in this study are ''barely significant'' (Ex. 500–197, pg. 69) and are no more significant than the associations observed with physical exercise. In addition, they state that the observed increases are negatively influenced by workers' self reporting of tasks, ''an inadequate definition of sciatica'' and recall bias.

OSHA is unsure as to what these critics mean by ''barely'' significant. The authors reported a statistically significant increase in sciatic pain among machine operators and carpenters compared to office workers. For machine operators the relative risk =1.6 (95% CI 1.2–2.2) and for carpenters was 1.7 (95% CI 1.3–2.4). This statistical significance remained even after controlling for a variety of risk factors (*e.g.*, age, seniority, education, physical exercise, smoking, car driving, and prior back accidents). Adjusted relative risks were 1.4 and 1.5.

The authors do acknowledge that the reporting of symptoms of sciatica can be subjective, as can a worker's perception of physical task. In order to minimize this type of bias, they used explicit descriptions of symptoms and tasks to ensure uniform understanding of the concepts. The authors also recognize the potential of recall bias to negatively influence the results. However, they note that this misclassification also depends not only on the recall error but also the incidence rate of the symptoms. They conclude that the recall error bias in the observed risk ratios is small if ''by the end of follow-up'' the rate of reporting symptoms among the misclassified subjects does not deviate much from the overall incidence rate. Thus, while OSHA acknowledges the potential bias pointed out by the critics of this study, the agency believes that these sources of bias have been taken into consideration in this study to such an extent that the observed increased risk ratios can be accepted with some confidence. In addition, OSHA believes that these observed risk ratios are more than barely significant and, when viewed in the context of other positive epidemiological evidence, contribute to the weight of evidence and the strength of the agency's overall health effects assessment.

Gibson Dunn & Crutcher also criticize four other epidemiology studies OSHA relied on in contributing to the strength of the agency's overall health effects assessment: two studies by Silverstein *et al.* (Exs. 26–34 and 26–1404), a study by Venning *et al.* (Ex. 500–41–49), and a study by Punnett *et al.* (Ex. 26–39). OSHA responds to criticisms of these 4 studies in on Section G:3-Exposure-Response.

VI. Risk Assessment

A. Introduction

The United States Supreme Court, in the *Benzene* decision (*Industrial Union Department, AFL-CIO* v. *American Petroleum Institute*, 448 U.S. 607 (1980)), has ruled that the OSH Act requires, prior to the issuance of a new standard, that a determination be made that there exists a significant risk of material impairment and that issuance of the new standard will substantially reduce that risk. The Court stated that ''before he can promulgate any permanent health or safety standard, the Secretary is required to make a threshold finding that a place of employment is unsafe in the sense that significant risks are present and can be eliminated or lessened by a change in practices'' (448 U.S. 642). The Court also stated that ''the Act does limit the Secretary's power to require the elimination of significant risks'' (448 U.S. 644).

In the Cotton Dust case (*American Textile Manufacturers Institute* v. *Donovan*, 452 U.S. 490 (1981)), the Court reaffirmed the position it had previously taken in the *Benzene* decision that a risk assessment is not only appropriate but required to identify significant health risks in workers and to determine if a new standard will reduce those risks. Although the Court did not require OSHA to perform a quantitative risk assessment in every case, the Court implied, and OSHA as a matter of policy agrees, that assessments should be put into quantitative terms to the extent possible.

The weight of evidence presented in the Health Effects section of this preamble (Section V) demonstrates a causal relationship between exposure to workplace risk factors and work-related musculoskeletal disorders. As discussed in that section, the major workplace risk factors include exposure to repetitive motion, force, awkward postures, contact stress, and segmental vibration. The Health Effects section also demonstrates that the risk associated with occupational exposure to these risk factors increases with frequent or prolonged exposure to these risk factors, and that the risk is increased when workers are exposed to more than one risk factor in a job.

OSHA has determined that there is substantial evidence that exposure to these biomechanical stressors at work can cause or contribute to the development of MSDs and that reductions in these stressors can reduce the number and severity of these work-related MSDs. The underlying evidence falls into three broad categories:

Studies of groups of workers showing a relationship between exposure to biomechanical risk factors in the workplace and an increased incidence or prevalence of MSDs;

Biomechanical studies that show that adverse tissue reactions and damage can occur when tissues are subjected to high forces and/or a high number of repetitive movements, which occur when workers are substantially exposed to biomechanical risk factors; and

Scientific and case studies that demonstrate that workplace interventions designed to reduce exposures to biomechanical risk factors are effective in reducing the internal forces imposed upon tissues and the incidence and severity of MSDs.

In the Health Effects section of this preamble, OSHA summarizes data and findings from more than 170 epidemiological studies of the incidence or prevalence of MSDs in groups of workers who are exposed to physical risk factors in their jobs. In most of these studies, the MSD prevalence of a group of exposed workers is compared to that in another worker group that is not exposed to the risk factors of interest. If the exposed group shows a higher MSD prevalence than does the reference group, the study provides evidence of an association between exposure and an increased risk of developing MSDs, particularly if the study is of good quality and adequately controlled for potentially confounding factors (such as age and gender) and biases.

Many of these epidemiological studies were reviewed by the National Institute for Occupational Safety and Health (NIOSH) in 1997 (Ex. 26–1) to evaluate the strength of the evidence for a causal relationship between several types of MSDs and the workplace risk factors of force, repetitive motion, awkward posture, and vibration. More than 600 peer-reviewed studies were critically reviewed, making this one of the largest human data bases ever built to examine work-related adverse health outcomes. NIOSH found that for most combinations of MSDs and risk factors, the evidence in humans that a causal relationship existed between workplace exposure to risk factors and the development of MSDs was either ''sufficient'' or ''strong.'' For a few MSD/risk factor combinations, there was insufficient evidence of a causal relationship, but in no case did NIOSH determine that there was evidence for the absence of a relationship between exposure to workplace risk factors and the development of MSDs. NIOSH concluded that '' * * * a substantial body of credible epidemiologic research provides strong evidence of an association between MSDs and certain work-related physical factors when there are high levels of exposure and especially in combination with exposure to more than one physical factor * * *'' (NIOSH 1997, ES p. xiv, Ex. 26-1).

A similar conclusion was reached by the experts participating in a workshop conducted by the National Academy of Sciences/National Research Council (NRC) (Ex. 26–37). For the NRC report, a panel of experts critically reviewed the methods used to select and evaluate the human studies relied on in the 1997 NIOSH study (Ex. 26–1). The 1999 NRC report concluded as follows:

[the association between MSDs and exposure to risk factors at work that have been] identified by the NIOSH review * * * as having strong evidence are well supported by competent research on heavily exposed populations.

There is a higher incidence of reported pain, injury, loss of work, and disability among individuals who are employed in occupations where there is a high level of exposure to physical loading than for those employed in occupations with lower levels of exposure. (Ex. 26–37)

In this context, NAS's use of the phrases ''heavily exposed'' and ''high level of exposure'' does not refer to any specific quantitatively defined level of exposure to biomechanical risk factors, but simply reflects that, in the epidemiological studies, groups of workers who were considered to be ''exposed'' to biomechanical risk factors experienced higher intensities and durations of exposure than did the comparison, or referent, groups of workers. In general, workers in the exposed groups were exposed to biomechanical risk factors on a nearly daily basis, and were usually exposed for most of each work shift. However, as shown by OSHA's summary of exposure-response data in the Health Effects section (Section V), many of these epidemiological studies placed workers in the exposed group even if they were exposed for only about one-quarter to one-half of the work shift. Later in this section, OSHA defines ''higher-risk'' workers as those who are exposed in excess of the final rule's job screening criteria, which generally reflects those workers as having two or more hours per shift of exposure to biomechanical risk factors.

Since the NIOSH and NAS reports, many additional epidemiological studies have been published and are contained in the rulemaking record. These studies have been reviewed by OSHA in detail in the Health Effects section, and their results add to the already substantial weight of evidence originally evaluated by NIOSH and NAS. OSHA is not alone in its determination that the epidemiological data base for ergonomics convincingly establishes a causal relationship between workplace exposure to risk factors and MSDs. Many experts who provided testimony in the record and appeared at OSHA's informal hearing agreed that sufficient epidemiological evidence exists to conclude that biomechanical factors at work cause or contribute to MSDs. These experts included researchers, medical professionals, and ergonomists (Exs. 37–1, 37–2, 37–9, 37–10, 37–13, 37–10, 37–15, 37–16, 37–17, 37–18, 37–21, 37–27; Tr. 843, Tr. 1048; Tr. 1112, Tr. 1103–1103, Tr. 1367, Tr. 9808–9809, Tr. 16802, Tr. 17566–17567, Tr. 8261, Tr. 2834, Tr. 9297, Tr. 16145, Tr. 1959–1960, Tr. 17358, Tr. 13330–13331, Tr. 3412).

That exposure to workplace risk factors can cause or contribute to MSDs is made more plausible by the growing body of studies of biomechanical effects, also summarized in the Health Effects section (Section V of this preamble), that are designed to explore how tissues react to mechanical stress and how those reactions are related to disease processes. OSHA presented detailed scientific information on the biomechanics and pathophysiology of MSDs in its Health Effects Appendicies, prepared at the time of the proposed rule (Ex. 27–1); the discussion below briefly summarizes the information reviewed in the Health Effects Appendicies and in the Health Effects section.

Although all soft musculoskeletal tissue can tolerate certain physical loads, these tissues will respond adversely if the load becomes excessive. Muscles, ligaments, tendons, and tendon sheaths can become inflamed with repetitive or prolonged loading, cartilage can deteriorate when subjected to abnormal loads, and nerves can exhibit dysfunction and eventually permanent damage if compressed or subjected to extended tension. Other studies have shown that the kinds of risk factors present in many industrial occupations can impose internal forces on soft musculoskeletal tissue sufficient to cause the kinds of physiologic responses described above. The relationships between external and internal loads have been demonstrated using both biomechanical models and direct measurement and observation in the workplace (see Section V, Health Effects).

Finally, evidence of the work-relatedness of MSDs comes from several studies and case reports that document the effectiveness of ergonomic interventions in reducing exposures to risk factors and the successes of individual companies' ergonomics programs in reducing the incidence or prevalence of MSDs and the severity of MSDs among their workers. After reviewing intervention studies, including both field and laboratory studies, the NRC (1998, Ex. 26–37) concluded that

> * * * specific interventions can reduce the reported rate of musculoskeletal disorders for workers who perform high-risk tasks. No known single intervention is universally effective. Successful interventions require attention to individual, organizational, and job characteristics, tailoring the corrective action to those characteristics.

The scientific evidence and case studies demonstrating that ergonomic interventions reduce excessive tissue loads and the associated tissue pathology, and reduce MSD incidence and severity, are summarized later in this section).

In addition to biomechanical risk factors present at work, the risk of developing an MSD is also influenced by individual, organizational, and social factors. Factors that affect individual susceptibility include age, general conditioning, and pre existing medical conditions. Although some of these individual factors have been identified in human studies as being statistically significant predictors of disease, they are generally much weaker predictors than are biomechanical factors of force, repetition, posture, and vibration (NRC 1998, Ex. 26–37). Organizational factors that have been linked to MSDs include poor job content (*e.g.*, lack of job variety) and job demands (*e.g.*, excessive or highly variable workload and time pressure). The importance of poor job content is difficult to evaluate, since this factor can coexist with biomechanical factors (for example, excessive workload can result in a worker needing to increase repetitive movement and/or force). Social factors refer to a lack of social support from management and supervisors, which can lead to psychological stress and dissatisfaction with work, both associated with an increased prevalence of MSDs. However, after evaluating the nature of psychosocial factors and their role in contributing to the risk of MSDs, OSHA has determined that, although psychosocial factors appear, at least in some studies, to have some relationship to the observed increases in the incidence of MSDs among workers exposed to risk factors, their effect is independent of that of biomechanical factors and is generally not as predictive of MSD risk as are biomechanical factors. The evidence reviewed by the Agency suggests that psychosocial factors may have a greater influence in determining the length of disability following development of an MSD than do biomechanical factors, but have shown weaker associations with the prevalence or incidence of MSDs than have biomechanical factors (see Section V.G.5 of the Health Effects Section for a discussion of the literature dealing with psychosocial effects). OSHA's finding is in accord with that of the NAS review (1999, Ex. 26–37).

OSHA believes that the human epidemiologic studies, the biomechanical and physiological studies, and the studies of the effectiveness of workplace ergonomic interventions together constitute a compelling body of evidence that demonstrates that exposure to risk factors at work is a major factor in the development of MSDs, and that reducing or eliminating exposures to these risk factors will reduce the number and severity of these MSDs.

The epidemiological data base that describes the associations between exposure to workplace risk factors and increased prevalence or incidence of MSDs is vast. The nature of the hazard and of the available data require OSHA to perform a different type of risk assessment than it performs to assess occupational risks from chemical exposures. There are many reasons for this, in particular the complex interactions among different kinds of exposures that lead to tissue injury and disorders and the difficulty of defining exposure metrics that reflect all of the various combinations of risk factors to which workers are exposed across industry. This is not to say that exposure-response relationships have not been observed or cannot be defined in specific circumstances; in fact, there are many cases in which the risk of MSDs has been quantitatively related to the degree and intensity of exposure. In the Health Effects section of this preamble (Section V), OSHA describes scientific studies that demonstrate a positive association between the magnitude and/or duration of exposure to workplace risk factors and the prevalence of MSDs, including upper extremity disorders and back injuries. OSHA concludes that these studies provide compelling evidence of the work-relatedness of MSDs, since a finding of positive exposure-response trends is one of the key findings necessary to establish a causal relationship between exposure and disease.

Using data on the incidence of work-related MSDs, risk can be quantified using a population-based approach similar to the one used by OSHA to quantify the risk of Hepatitis B among workers with frequent occupational exposure to blood and other potentially infectious material (56 FR 64004). For this final ergonomics program rule, OSHA uses a similar approach in its final risk assessment. In this assessment, OSHA relies on data from the Bureau of Labor Statistics (BLS) to estimate the annual incidence of work-related MSDs in different industry sectors and occupations, by type of injury and type of exposure. A description of these data and OSHA's analytical approach are described in part B below, and the results of this analysis appear in part C.

Having quantified the risk, it is important to determine the extent to which the standard is likely to reduce that risk. In the case of this ergonomics program standard there is abundant evidence of the effectiveness of ergonomic programs. This evidence comes from a variety of published studies, articles, and unpublished data that describe the reductions in risk ergonomics programs have actually achieved in the workplace. Most commonly, this evidence is expressed in terms of reductions in injury rates and decreases in the numbers of lost workdays caused by MSDs. OSHA's discussion of these data appears in part D, below. The Agency presents the results of its risk analysis in parts C and D; comments on the preliminary risk assessment (64 FR 65926) follow these sections.

B. Data Sources and Analytical Approach

The annual Survey of Occupational Injuries and Illnesses conducted by the Bureau of Labor Statistics (BLS) is the principal data source for evaluating the risks to employees of developing a work-related musculoskeletal disorder. This survey is conducted under a joint federal/state program that collects workplace injury and illness data from about 165,000 private industry establishments. The survey requests information only on non-fatal injuries and illnesses, and excludes the self-employed, farms with fewer than 11 employees, private households, and employees in federal, state, and local government agencies.

For this survey, selected employers are required to provide statistics on the total number of injuries and illnesses recorded on the OSHA Form 200 (the ''OSHA Log''), as well as information describing the nature and causes of their lost workday injuries and illnesses. Thus, according to the BLS, the data provided by employers ''* * * reflect not only the year's injury and illness experience, but also the employer's understanding of which cases are work-related under current record keeping guidelines of the U.S. Department of Labor.'' Information from employers is provided in sufficient detail to permit the BLS to systematically code each reported case and develop estimates of the numbers and incidence of each specific type of LWD injury and illness for the United States as a whole, by industry sector and by occupation.

Although the BLS data are the best available data on the number and kinds of job-related injuries and illnesses occurring among U.S. workers in any given year, there is no single BLS-reported number that represents all employer-reported musculoskeletal injuries and illnesses occurring in that year. Instead, employer-reported injuries and illnesses are coded by the BLS according to a classification system that categorizes each incident by type of injury or illness and by nature of the exposure event leading to the injury or illness (Ex. 26–1372). The types of disorders that are addressed by the standard fall into several of these BLS injury and illness categories.

To use these data, OSHA identified the kinds of cause-specific injuries and illnesses, as coded by the BLS, that reflect MSDs of the kinds that will be covered by the ergonomics program standard. An OSHA panel, which included an occupational physician and two professional ergonomists, examined the BLS listing of occupational injury and exposure event codes and their definitions from the manual provided to state personnel who code the data from the BLS employer survey. The table contained in Appendix VI-A at the end of this Risk Assessment section provides the list of injury categories that were initially selected by this panel as being likely to include at least some work-related MSDs. From this initial list, the panel selected a subset of injury categories that predominately included work-related MSDs of the type that has been associated with exposure to the biomechanical risk factors addressed by the final rule; these categories appear in Table VI–1. Of the injury categories selected, OSHA chose to base its analysis exclusively on six injury categories that were deemed by these experts to be most relevant and most likely to represent a large proportion of lost workday MSDs; in other words, OSHA deliberately excluded several categories such as ''traumatic injuries to bones, nerves, and spinal cord,'' ''symptoms involving nervous and musculoskeletal systems, unspecified,'' and ''disorders of the peripheral nervous system, unspecified.'' The injury categories included by OSHA for the risk assessment were:

Sprains, Strains, and Tears;
Back Pain, Hurt Back;
Soreness, Hurt, except back;
Carpal tunnel syndrome;
Hernia; and
Musculoskeletal and connective systems diseases and disorders.

Table VI-1. BLS Injury Categories Consisting Predominately of Employer-Reported Musculoskeletal Disorders (Continued)

BLS Code	Nature of Injury	Description
021	Sprains, strains, tears	This nature group classifies cases of sprains and strains of muscles, joints tendons, and ligaments. Diseases or disorders affecting the musculoskeletal system, including tendonitis and bursitis, which generally occur over time as a result of repetitive activity should be coded in Musculoskeletal system and connective tissue diseases and disorders, major group 17. Includes avulsion, hemarthrosis, rupture, strain, sprain, or tear of joint capsule, ligament, muscle, or tendon. Excludes hernia (153), lacerations of tendons in open wounds (034), torn cartilage (011).
0972 0973	Back pain, hurt back Soreness, pain, hurt, except the back	Subcategories under nature group 097, Nonspecified injuries and disorders, which includes traumatic injuries and disorders where some description of the manifestation of the trauma is provided and generally where the part of body has been identified. Subcategory 0972 includes hurt back, backache, low back pain.
1241	Carpal tunnel syndrome	Subcategory under nature group 124, Disorders of the peripheral nervous system, which includes the nerves and ganglia located outside the brain and spinal cord.
153	Hernia	This nature group classifies hernias of the abdominal cavity. Includes: femoral (1539), esophageal (1539), hiatal (1532), inguinal (1531), paraesophageal (1539), scrotal (1531), umbilical (1539), and ventral (1533) hernias. Excludes: herniated disc (011), herniated brain (1231), and strangulations (091).
17	Musculoskeletal system and connective tissue diseases and disorders.	This major group classifies diseases of the musculoskeletal system and connective tissue.
170	Musculoskeletal system and connective tissue diseases and disorders, unspecified	
171	Arthropathies and related disorders (arthritis)	This nature group classifies joint diseases and related disorders with or without association with infections. Includes: ankylosis of the joint, arthritis, arthropathy, and polyarthritis. Excludes: disorders of the spine (172), gouty arthropathy (1919), rheumatic fever with heart involvement(131).

Table VI-1. BLS Injury Categories Consisting Predominately of Employer-Reported Musculoskeletal Disorders (Continued)

BLS Code	Nature of Injury	Description
172	Dorsopathies	This nature group classifies conditions affecting the back and spine. Includes: spondylitis and spondylosis of the spine (1729); intevertebral disc disorders, except dislocation (1723); sciatica (1721); lumbago (1722); and other nontraumatic backaches (1729). Excludes: dislocated disc (011), curvature of the spine (1741), fractured spine (012), herniated disc (011), ruptured disc (011), traumatic sprains and strains involving the back (021), and other traumatic injuries to muscles, tendons, ligaments, or joints of the back (02), and traumatic back pain or backache (0972).
173	Rheumatism, except the back	This nature group classifies disorders marked by inflammation, degeneration, or metabolic derangement of the connective tissue structure of the body, especially the joints and related structures of muscles, bursae, tendons and fibrous tissue. Generally, these codes should be used when the condition occurred over time as a result of repetitive activity. Includes: rotator cuff syndrome (1739), rupture of synovium (1739), and trigger finger (1739). Excludes: rheumatism affecting the back is included in code (172), traumatic injuries and disorders affecting the muscles, tendons, ligaments and joints (02).
174	Osteopathies, chondropathies, acquired deformities	This group is comprised of diseases of bones, diseases of cartilage, and acquired musculoskeletal deformities. Includes: osteomyelitis, periostitis and other infections involving bone; and acquired curvature of the spine.
179	Musculoskeletal system and connective tissue diseases and disorders, n.e.c.	This nature group classifies musculoskeletal system and connective tissue diseases and disorders that are not classified elsewhere.

Source: Occupational Injury and Illness Classification Manual, Bureau of Labor Statistics, December 1992 (Ex. 26-1372)

For this analysis, OSHA is interested in capturing only those injuries and illnesses that are associated with exposure to the risk factors addressed in the final rule. These risk factors are repetitive motion, excessive force, awkward postures, contact stress, and segmental vibration. The annual BLS survey does not break out the causes of injuries and illnesses captured by the survey in a manner that precisely matches the kinds of risk factor exposures covered by the rule. However, the OSHA panel did identify the three exposure event categories defined by the BLS that are the most closely related to these risk factors. These are:

- ''Repetitive motion,'' which reflects the risk factors of repetitive motion, sometimes combined with force and/or awkward posture, and contact stress, which is a combination of repetitive motion and force;
- ''Overexertion,'' which includes activities such as lifting/lowering, pushing/pulling, holding/carrying, and throwing, and thus reflects the risk factor of force, sometimes combined with repetitive motion and/or awkward posture; and
- A subcategory of ''bodily reaction'' that includes ''bending, climbing, crawling, reaching, twisting,'' which reflects the risk factor of awkward posture.

The BLS definitions for these exposure event categories appear in Table VI–2. Note that musculoskeletal injuries and illnesses caused by acute events such as slips, trips, falls, being struck by objects, or by motor vehicle accidents are *excluded* from the data relied on in OSHA's risk analysis (because they are not included in the coverage of the final rule (see paragraph (a) of the regulatory text)). The process used by OSHA to identify those injury and exposure event categories from which to select the BLS data represents the closest approximation possible from the data available to OSHA of the MSDs that the final rule will actually cover.

The BLS injury and illness coding system also includes two exposure event categories that reflect exposure to vibration involving damage to the nerves or circulatory system (Ex. 26–1372). They include:

- Event code 05, rubbed or abraded by friction or pressure; this code includes injuries caused by rubbing or abrasion by ''objects being handled,'' and includes ''superficial injuries such as blisters, scratches, or abrasions,'' as well as those involving nerve or circulatory damage, and
- Event code 06, rubbed, abraded, or jarred by vibration, which includes injuries caused by vibration of mobile equipment or vehicles, as well as other machines or equipment.

Table VI-2. Description of BLS Exposure Event Categories Corresponding to Workplace Risk Factors Associated with Work-Related Musculoskeletal Disorders

BLS Code	Nature of Exposure Event	Description
21	Bodily reaction [a]	Codes in this major group apply to injuries or illnesses resulting from a single incident of free bodily motion which imposed stress or strain upon some part of the body. Generally, codes in this major group apply to the occurrence of strains, sprains, ruptures, nerve damage or other internal injuries or illnesses resulting from the assumption of an unnatural position or from voluntary or involuntary motions induced by sudden noise, fright, or efforts to recover from slips or loss of balance (not resulting in falls). This major group includes cases involving musculoskeletal or internal injury or illness resulting from the execution of personal movements such as walking, climbing, bending, etc. when such movement in itself was the source of injury or illness. Group does not include falls.
210	Bodily reaction, unspecified	
211	Bending, climbing, crawling, reaching, twisting	
212	Sudden reaction when surprised, frightened, startled	
213	Running--without other incident	
214	Sitting	
215	Slip, trip, loss of balance--without fall	
216	Standing	
217	Walking--without other incident	
	Bodily reaction, n.e.c.	

Table VI-2. Description of BLS Exposure Event Categories Corresponding to Workplace Risk Factors Associated with Work-Related Musculoskeletal Disorders (Continued)

BLS Code	Nature of Exposure Event	Description
22	Overexertion	Overexertion applies to cases, usually non-impact, in which the injury or illness resulted from excessive physical effort directed at an outside source of injury or illness. The physical effort may involve lifting, pulling, pushing, turning, wielding, holding, carrying, or throwing the source of injury/illness. Free bodily motions that do not involve an outside source of injury or illness are classified either in major group 21, Bodily reaction, or in major group 23, Repetitive motion.
220	Overexertion, unspecified	
221	Overexertion in lifting	
222	Overexertion in pulling or pushing objects	
223	Overexertion in holding, carrying, turning, or wielding objects	
224	Overexertion in throwing objects	
229	Overexertion, n.e.c.	
23	Repetitive motion	Repetitive motion applies when an injury or illness resulted from bodily motion which imposed stress or strain upon some part of the body due to a task's repetitive nature. Instances of carpal tunnel syndrome (CTS) from typing or any type of keyentry, including the use of calculators or nonscanning cash registers are coded 231. CTS resulting from cutting with a knife, repeated use of a power tool should be coded Repetitive use of tool (232). If an injury or illness resulted from prolonged vibration in long distance driving, the event should be coded in event group 061, Rubbed, abraded, or jarred by vehicle or mobile equipment vibration.
230	Repetitive motion, unspecified	
231	Typing or key entry	
232	Repetitive use of tools	
233	Repetitive placing, grasping, or moving objects, except tools	
239	Repetitive motion, n.e.c.	

[a] The subcategory of "Bending, climbing, crawling, reaching, twisting" is the only subcategory from the Bodily Reaction category used by OSHA to define MSDs.

Source: Occupational Injury and Illness Classification Manual, Bureau of Labor Statistics, December 1992 (Ex. 26-1372)

MSDs caused by segmental vibration are thus included with those caused by whole-body vibration in both event categories, which makes it difficult to separate out those vibration-induced injuries and illnesses related only to segmental vibration, one of the risk factors covered by the standard. The BLS estimated that a total of 5,465 injuries related to exposure events classified under these two categories (excluding injuries involving the eyes) had occurred in 1996 (see BLS Table R32 for 1996, available at http://www.bls.gov/oshc_d96.htm). Because it is not possible to identify the number of injuries associated with segmental vibration, OSHA has included in its analysis only those MSDs related to the three event codes of overexertion, repetitive motion, and the subcategory of bodily reaction described above. The injury/illness and event codes used by OSHA in the Risk Assessment and Significance of Risk sections for the final rule are the same as those used to support these analyses of the proposed rule. OSHA's decision not to include vibration-induced injuries and illnesses in the universe of MSDs means that the risks estimated in the final Risk Assessment section, and the estimates in the Significance of Risk section, are understated.

OSHA received numerous comments on its selection of injury/illness and exposure event codes from those used in the BLS classification system. In particular, several commenters objected to OSHA's inclusion of injuries categorized as ''strains, sprains, and tears,'' because, in their view, such injuries reflect acute injury events, while OSHA's ergonomics program standard was intended to address injuries that arise from cumulative damage through long-term exposure to risk factors. These commenters include, among others, the Chamber of Commerce (Ex. 30–1722), the American Iron and Steel Institute (Exs. 30–3951, 32–206), Gibson, Dunn, & Crutcher on behalf of numerous clients (Exs. 500–197, 32–241), the National Coalition on Ergonomics (Ex. 32–368), the American Forest & Paper Association (Ex. 30–3865), the AEI-Brookings Joint Center (Ex. 30–3911), Edison Electric Institute (Ex. 32–300–1), the Center for Office Technology (Ex. 30–2208), Integrated Waste Services Association (Ex. 30–3853), Organization Resources Counselors (Ex. 30–3813), the American Meat Institute (Ex. 30–3677), Guilford Mills (Tr. pp. 11519–11520, 11566–11567), the Puerto Rico Manufacturers Association (Ex. 30–3348), and the National Paint and Coatings Association (Ex. 30–4340). In support of their views, these commenters point to the BLS's definition of ''strains, sprains, and tears,'' which appeared on Table VI–1 of the preamble to the proposal (64 FR 65928—65929) and reads as follows:

> This nature group classifies cases of sprains and strains of muscles, joints, tendons, and ligaments. Diseases or disorders affecting the musculoskeletal system, including tendinitis and bursitis, which generally occur over time as a result of repetitive activity should be coded in Musculoskeletal System and Connective Tissue Diseases and Disorders, major group 17. (Ex. 26–1372)

Based on this definition, Gibson, Dunn, & Crutcher conclude that cases classified as sprains, strains, and tears represent single-incident traumatic injuries and ''are not MSDs'' (Ex. 500–197, p. I–166).

To further support their view that strains, sprains, and tears reflect acute injury events and not cumulative trauma, Gibson, Dunn, & Crutcher note that most of the strain, sprain, and tear injuries described in OSHA's preliminary risk assessment were associated with overexertion, which is defined by the BLS as follows:

> Overexertion applies to cases, usually non-impact, in which the injury or illness resulted from excessive physical effort directed at an outside source of injury or illness * * * Free bodily motions that do not involve an outside source of injury or illness are classified either in major group 21, Bodily Reaction, or in major group 23, Repetitive Motion. (Ex. 26–1372)

Thus, Gibson, Dunn, and Crutcher argue that

> Clearly, nothing in this definition suggests that overexertion injuries develop gradually over time. To the contrary, this definition expressly excludes injuries that result from repetitive motion. There is simply no evidence that sprains, strains, and tears associated with overexertion meet the definition of an MSD. (Ex. 500–197, p. I–167)

Similarly, the Chamber of Commerce stated: ''It is not difficult to imagine that many, if not most of these injuries * * * may well have occurred as the result of a single instantaneous event.'' (Ex. 30–1722)

Gibson, Dunn & Crutcher (Ex. 500–197), AISI (Exs. 32–206, 30–3951), the American Forest & Paper Association (Ex. 30–3865), the American Meat Institute (Ex. 30–3677), and the Hon. David M. McIntosh of the U.S. House of Representatives (Ex. 30–542) all objected to the inclusion of cases from BLS category 0972 (back pain, hurt back) in the universe of MSDs on the grounds that these are traumatic injuries as well. To support this position, Gibson, Dunn, & Crutcher pointed to OSHA's *Record Keeping Guidelines for Occupational Illnesses and Injuries*, commonly known as the ''Blue Book.'' These guidelines instruct employers how to record occupational injuries and illnesses on their OSHA 200 logs. Gibson, Dunn & Crutcher argued that, in the Blue Book, OSHA ''concedes'' that back cases should be categorized as injuries rather than illnesses. According to Gibson, Dunn and Crutcher (Ex. 500–197):

> OSHA states that back cases are ''injuries'' that are ''usually triggered by an instantaneous event'' for purposes of OSHA 200 recording, [but] converts them into ''illnesses'' that develop ''gradually over time'' for purposes of its MSD statistics * * * The bottom line is that OSHA has no reliable data regarding the causes of back pain and back injuries. OSHA allows employers to ''generalize'' about back pain for purposes of OSHA 200 recording precisely because its causes are often indeterminate.

OSHA has carefully considered these comments and finds them unpersuasive. It is necessary and appropriate to include these BLS categories to arrive at an accurate estimate of the risk posed by the biomechanical risk factors addressed in this standard.

First and foremost, OSHA is issuing its final ergonomics program standard because of substantial evidence that workers who are regularly exposed to biomechanical risk factors are at an increased risk of MSDs and the pain and disabilities associated with them. Whether these injuries and illnesses come about because of an acute event or because of pathology that develops over a longer term is not germane to the issue of whether workers who are regularly exposed need protection. The sole consideration is that increased exposure to biomechanical risk factors increases the risk to the worker. For example, a worker whose job involves heavy lifting on a regular basis is at an elevated risk of suffering a low back disorder. Such a disorder may arise either because repeated lifting is causing cumulative wear resulting in degenerative changes to the disc, or because the stress imposed on the spine during lifting can overcome the capacity of the disc to withstand compression, resulting in acute structural failure (see Section V.E on the health evidence for low-back disorders). Although a worker who lifts heavy loads infrequently may be at risk from acute failure, the worker who lifts frequently as part of their regular job is at greater risk via either mechanism.

Furthermore, there is substantial evidence in the record that many of the injuries coded as strains, sprains, and tears in fact develop gradually over time. Several commenters believed that it was appropriate for OSHA to include statistics on strains, sprains, and tears in its assessment of MSD risks. For example, the AFL-CIO, in their post-hearing brief, stated that

The industry is just plain wrong on this point [that back injuries are traumatic injuries]. The BLS survey is based on employer reports of injuries. To simplify recording, OSHA recording criteria specifically specify that back injuries, one major source of MSDs, should be recorded as injuries, even if they result from chronic exposure conditions. Disorders related to repeated trauma, including carpal tunnel syndrome are to be recorded as illnesses. * * * Thus, it is OSHA's recording criteria and BLSs coding rules and definitions that result in many MSDs, particularly back injuries, being classified as sprains, strains, and tears. This category includes injuries that may result from a single exposure and those that result from repeated activities. OSHA has limited the types of strains, sprains, and tears that are covered [in its risk assessment] to those * * * associated with] exposures that are covered by the rule (*e.g.*, overexertion, repetition). (Ex. 500–218, p. 13–14)

Testimony from Dr. Frank Mirer of the United Auto Workers, who is also a member of the BLS Labor Research Advisory Committee, explained why MSDs of the back are frequently recorded as sprains and strains:

You have to understand the reality of this BLS database, which is derived from [the] OSHA 101 form submitted by management medical departments to OSHA or to the BLS. Now when a worker goes up to the medical department * * * all they know is they hurt. And most of them see a nurse and their disorder is just thrown into a bin. Back conditions are all injuries. They come as strain and sprain * * *. [W]e have acute flare ups, just as a back injury is a chronic condition and has an acute flare up. So standard practice in the industry * * * is [that] cases [considered to be] of ergo interest * * * [include] sprain and strain injuries that are not accompanied by a fall or some other traumatic [event] * * *. (Tr. 5896–5897)

When asked whether strains and sprains due to overexertion or repetition were likely to be related to the risk factors covered by the standard, both Dr. Rosecrance and Mr. Alexander agreed. Dr. Rosecrance testified that injuries classified as sprains or strains are appropriately considered MSDs, depending on the events leading to the injury:

* * * I look at an MSD * * * as a disorder affecting muscles, tendons, ligaments, bone, connective tissue. And certainly in my definition of MSD, a sprain would meet that because a sprain is a tear to a ligament * * * [It] perhaps [might] be a traumatic one or from an acute injury like a slip or a trip * * *. When we review, let's say, the OSHA 200 Log and there is a strain or sprain on there, I will ask * * * what was the cause of that sprain or strain? Was the strain from repetitive use or was it a strain from an acute type of injury?

Some rulemaking participants provided evidence to the record documenting that back disorders were frequently recorded as strains and sprains without regard to the nature of the exposure or events associated with each case. For example, the post-hearing submission of the United Food and Commercial Workers Union (UFCW) (Ex. 500–133), which contained copies of OSHA–200 logs (Ex. 500–133–2), reported finding MSDs categorized as strains and sprains, back pain, hurt back, carpal tunnel syndrome, hernia, and disorders associated with repeated trauma. According to the UFCW, retail stores primarily categorized such MSDs as sprains and strains, back pain and hurt backs, and injuries, and seldom classified MSDs as illnesses. In contrast, the UFCW stated that meatpacking industry logs more often accurately record MSDs as illness, reflecting the greater experience this industry has in dealing with ergonomic issues. A review of OSHA 200 logs submitted by the Teamsters (Ex. 500–146) also shows that disorders that are clearly recognized as MSDs, such as carpal tunnel syndrome and tendinitis, are nevertheless often recorded by employers as injuries, which in turn would be described in the BLS statistics as strains and sprains.

Other rulemaking participants described the use of sprain and strain injury categories for ergonomic injuries in other injury classification systems. In describing the province of Victoria's (Australia) 1999 ergonomics regulation, which combined Victoria's earlier manual handling and occupational overuse syndrome (OOS) regulations, Mr. David C. Caple, Director, David Caple & Associates Pty Ltd., testified that both repetitive injuries and back injuries were combined under one generic sprain and strain category by that regulation (Tr. 2723–2724). The Ford Motor Company's injury classification system also combines strain and sprain injuries with cumulative trauma disorders and other disorders of interest to the company's ergonomics committee (Tr. 5826). When asked whether sprains and strains are included within the category of repetitive motion disorders under Oregon's workers' compensation law, Mr. Goodman replied that they are often classified in that category, depending on the events leading to the injury. He explained that Oregon's law defines an injury as ''sudden and unexpected in onset'; thus, strains and sprains would be considered repetitive motion disorders if the onset was slow and insidious rather than sudden (Tr. 13694).

As described by the AFL–CIO submission and Dr. Frank Mirer's testimony, all back disorders are classified as injuries rather than illnesses, under OSHA's recordkeeping rules; as a result, back disorders are commonly classified as strains and sprains, regardless of whether the disorder arose from an acute, traumatic event or from cumulative damage caused by prolonged exposure to risk factors. Evidence in the record indicates that most cases of back pain arising from exposure to risk factors of the type covered by the final rule do not develop suddenly but are instead cases involving gradual onset, which makes it difficult to identify or relate the back pain to a single precipitating event. OSHA's witness, Dr. Stover Snook, testified that

I am of the view and most scientists are of the view that that is not typically how low back pain develops through traumatic things like playing football on a weekend. It usually develops gradually and insidiously, most of it, not all of it, but most of it does. (Tr. 884)

In a study of back braces, Walsh and Schwartz (Ex. 30–3857–7) also characterized the nature of work-related back disorders as being of gradual onset:

Most back injuries are not the result of a single traumatic incident but rather a compilation of minor traumatic events occurring during normal working conditions for reasons that are seldom obvious to the individual worker. Successive injuries result in more severe impairment and increase the probability of long-term disability * * *. In fact, improper body mechanics and unhealthy work habits may take their toll on a daily basis. In recent years, there has evolved a body of evidence that suggests that the etiology of most but not all back pain is due to insidious and chronic deterioration of the intervertebral disc, facet joints, and ligaments in the back caused by biomechanical wear and tear. (Ex. 30–3857–7, p. 245)

OSHA's analysis of the biomechanical and pathological literature dealing with work-related back pain leads to conclusions that are consistent with these characterizations (see Section V, Health Effects).

Because back disorders are recorded as injuries, notwithstanding the mechanistic evidence described above that characterizes most back disorders as being of chronic onset, practicing ergonomists believe that it is important to investigate the underlying events associated with recorded cases of strain or sprain to determine whether the injury is related to excessive exposure to ergonomic risk factors. This practice was described in the testimony of Dr. John Rosecrance, Assistant Professor, University of Iowa and Mr. David Alexander, President of Auburn

Engineers, Inc. and reflects an understanding that the classification of back disorders as strains and sprains often does not mirror the true nature of these disorders.

OSHA's final risk assessment (like its proposed assessment) relies on statistics for strains and sprains that are associated only with overexertion (*i.e.,* lifting/lowering, pushing/pulling, holding/carrying), repetitive motion, and bodily reaction (*i.e.,* awkward postures). Thus, OSHA's treatment of the BLS data exclude strains and sprains that were determined by ergonomists or health care professionals to arise from accidents, such as slips or falls. Based on the evidence and testimony reviewed above, strains and sprain injuries captured by the BLS system and classified under these three exposure event codes properly reflect musculoskeletal disorders that arise as a result of exposure to the risk factors covered in the final rule. Further, as described below in part C of the risk assessment, OSHA has refined its analysis, based on data in the record, to estimate the number and incidence of MSDs occurring among those workers who are exposed to risk factors at levels that meet the final rule's screen; OSHA believes that this refinement will ensure that the Agency is accurately stating the risks posed to employees covered by the final rule.

The United Auto Workers (Ex. 32–185), argued that OSHA was underinclusive, not overinclusive, in its choice of the BLS categories that represent MSDs. In addition to the six categories chosen by OSHA, the UAW argued that OSHA should have included a substantial fraction of the injuries and illnesses categorized as ''other'' and ''multiple injuries'' as well. OSHA agrees that these injury categories contain MSDs that are relevant to OSHA's risk analysis. However, since data are not available to describe the proportion of the injuries classified under these categories that are, in fact, MSDs, the Agency has not included them in its revised risk assessment. This decision also means that the risks presented by OSHA in its Risk Assessment section and estimated in the Significance of Risk section are understated.

As explained by OSHA in its preliminary risk assessment for the proposed rule, risk estimates based on the BLS data understate the true risk of incurring a work-related MSD posed to employees who are exposed to workplace risk factors that are associated with the development of MSDs, for several reasons. First, the BLS data include only those lost workday (LWD) cases that resulted in at least 1 day spent away from work, and thus do not capture either non-lost workday MSD cases nor MSD cases that resulted in the employee being temporarily reassigned to another job. Second, some LWD MSDs reported to the BLS by employers are likely to have been coded in BLS injury categories that are excluded from OSHA's categories of overexertion, repetition, and bodily reaction (bending, climbing, crawling, reaching, twisting); for example, injuries due to segmental vibration are included in BLS event categories other than those included by OSHA in its analysis, and, as pointed out by the UAW (Ex. 32–185), the non-specific BLS injury categories of ''other'' and ''multiple injuries'' are also likely to contain MSDs.

Finally, the incidence of MSDs reported by the BLS is the reported incidence of MSDs occurring among *all* workers in the industries surveyed (on a full-time-equivalent basis); that is, the incidence for each industry sector is calculated by BLS as the number of MSD cases reported in 1996 divided by the total number of full-time equivalent employees in that industry sector in 1996. Expressing the incidence in this way has the effect of diluting the estimated incidence of disorders that are actually occurring among exposed employees, *i.e.,* those who routinely are exposed to workplace risk factors that have been associated with the development of work-related MSDs. The risk to exposed employees is substantially higher than the risk reflected by the BLS estimates of MSD incidence, because most of the injuries reported to the BLS will in fact have occurred among that subset of workers whose jobs expose them to these risk factors (that is, if the incidence were calculated using the much smaller denominator that reflects the number of exposed employees, the resulting incidence estimate would be higher). Evidence that workers exposed to workplace risk factors are at substantially higher risk than other workers in their industry comes from the large data base of formal scientific studies of exposed worker populations that have demonstrated a positive relationship between exposure to workplace risk factors and the relative risk of developing an MSD (see the Health Effects section of this preamble). These studies show that the prevalence of MSDs among exposed employees is often 2- or 3-fold higher, and can be as much as 10 to 20 times higher, as the prevalence among workers who are not so exposed.

In the next part of the Final Risk Assessment, OSHA presents two alternative approaches to quantifying risks posed to workers who are exposed to biomechanical risk factors on the job. The first approach is the same as that used in the Preliminary Risk Assessment presented in with the proposed rule. In that approach, OSHA's estimates of the risk are based on the numbers and incidence of MSDs reported by BLS (based on OSHA's definition of MSDs) by industry sector and by occupation. OSHA's second approach responds to a number of comments made in the record that the Agency's Preliminary Risk Assessment did not (1) properly subtract out MSD cases that occurred among employees who were not heavily exposed to physical risk factors, and (2) did not properly account for background risk (*i.e.,* that part of the risk that could not be attributed to workplace exposure or that occurs among the general population). To address these comments, the Agency was able to use data that became available in the record to more precisely characterize the MSD risk in the subset of employees who are the most heavily exposed to risk factors covered in the final rule, and to account for background risk. OSHA's underlying rationale is explained fully in part C below.

C. Results

Table VI–3 provides the BLS estimates of the number of injuries and illnesses reported nationwide by employers for 1996, by nature of injury and type of workplace exposure, for all injury and exposure event categories determined by OSHA to represent the MSDs covered by the standard. Overall, OSHA estimates that there were a total of 647,344 lost workday MSDs that occurred in 1996, as derived from employer reports of thoseTable VI–3 here illnesses and injuries. These disorders represent about 34.4 percent of the 1.88 million LWD injuries and illnesses reported by employers in 1996 (BLS press release 97–453, 12/17/97).

TABLE VI–3.—ESTIMATES OF THE NUMBER OF LOST WORKDAY MUSCULOSKELETAL DISORDERS (MSDS) IN 1996, BY NATURE OF INJURY AND TYPE OF WORKPLACE EXPOSURE

Nature of injury	BLS Code	Type of workplace exposure					
		Total for all exposures	Overexertion	Repetition	Subtotal (O and R)	Bodily Reaction [a]	Subtotal
Total for all lost work-day injuries	....	....	526,594	73,796	600,390	79,475	679,865
Musculoskeletal Disorders:							
Sprains, Strains, Tears	021	819,658	424,290	12,872	437,162	66,068	503,230
Back Pain, Hurt Back	0972	52,046	28,046	861	28,907	4,646	33,553
Soreness, Hurt, except back	0973	73,542	17,984	5,811	23,795	2,896	26,691
Carpal tunnel syndrome	1241	29,937	....	29,809	29,809	....	29,809
Hernia	153	29,624	25,819	322	26,141	670	26,811
Musculoskeletal and connective system diseases and disorders	17	35,238	7,761	18,278	26,039	1,211	27,250
Total Number of MSDs	....	1,040,045	503,900	67,953	571,853	75,491	647,344

[a] Data from BLS included only those injuries reporeted to have been associated with ''Bending, climbing, crawling, reaching, twisting.'' Source: BLS-reported estimates for BLS nature-of-injury codes 021, 0972, 0973, 1241, 153, and 17, and for BLS exposure events of overexertion, repetition, and bodily reaction (1996).

For 1998, the BLS estimated that there were 592,500 MSDs that occurred throughout U.S. industry, representing an 8.5-percent decline from 1996 (''Lost-Worktime Injuries and Illnesses: Characteristics and Resulting Time Away From Work, 1998,'' U.S. Bureau of Labor Statistics, available at http://www.bls.gov/news.release/osh2.nr0.htm). This decline is consistent with the pattern seen from 1992–1996, when both MSD and overall injury rates declined. For the final risk assessment, OSHA has continued to use 1996 BLS data in order to be consistent with the economic analysis, which uses 1996 as a base year throughout. For example, 1996 is the base year from which data are used to estimate numbers of establishments and employees, revenues, profits, and costs associated with the final rule.

About 66 percent of the estimated number of MSDs reported to the BLS in 1996 were categorized by BLS coders as ''sprains, strains, and tears'' due to overexertion. As discussed in part B above, OSHA received many comments on the use of BLS data on injuries classified by the BLS as sprains, strains, and tears; these commenters objected to including these injuries in the risk assessment on the grounds that injuries classified as strains, sprains, and tears reflect acute injuries that cannot be considered MSDs. Based on the evidence and testimony presented in part B above, however, OSHA has determined that it is appropriate to include strains, sprains, and tears that are associated with the exposure events of overexertion, repetitive motion, and bodily reaction in the universe of relevant MSDs because these injuries arise from exposure to relevant risk factors. Furthermore, OSHA believes that, when MSDs result from exposure to the biomechanical risk factors covered in the final rule, it is not important to make any distinction between whether those injuries arose from acute or chronic events. The purpose of the standard is to reduce the risk of MSDs resulting from exposure to risk factors, regardless of the duration of the exposure preceding to those injuries and illnesses.

As further evidence of the appropriateness of including strain, sprain, and tear injuries in the risk assessment, OSHA presented BLS data in the preliminary risk assessment that provides additional information on the nature of the injuries and the exposure events associated with those injuries [64 FR 65931]; these data are reproduced in Table VI–4. For this analysis, OSHA obtained from the BLS a breakout of the estimated number of injuries, by body part and by type of overexertion event. This breakout appears in Table VI–4 and shows that about 89 percent of these sprain, strain, and tear injuries (379,615) are comprised of injuries due to lifting /lowering, pushing/pulling, holding/carrying, or throwing, all of which are activities involving force. For the remaining 11 percent of the BLS-coded sprain, strain, and tear injuries, the exact nature of the overexertion exposure was either not reported by the employer or did not fall into any other exposure classification under the BLS system. Of the 379,615 injuries for which the nature of the overexertion exposure was reported, the majority (88 percent) affected body parts that are consistent with the kinds of injuries addressed by the final standard, such as the upper extremities, neck and shoulder, lower extremities, and back. Fifty-two percent of these injuries represent back injuries due to lifting or lowering. Only a small proportion (12 percent) of sprain, strain, and tear injuries reported by the BLS in 1996 affected body parts that are not relevant to MSDs. Therefore, OSHA is confident that the vast majority of BLS-coded sprain, strain, and tear injuries are appropriately included in the estimated number of MSDs for 1996, and that the judgment of the OSHA expert panel in selecting appropriate BLS injury and event categories for Table VI–4 here the risk analysis is confirmed by this additional breakout and review of the BLS data.

Table VI-4. Number and Percentage of All BLS-Reported Sprain, Strain, and Tear Injuries That are Work-Related Musculoskeletal Disorders (i.e., Caused by Overexertion), by Body Part and Nature of Exposure, 1996

Body Part Affected	Type of Overexertion Exposure						
	Lifting/ Lowering	Pushing/ Pulling	Holding/ Carrying	Throwing	Unspecified	Not Elsewhere Classified (NEC)	Total excluding NEC and Unspecified
Shoulder	20,728	8,639	6,895	395	2,277	2,177	36,657
Back	174,107	33,805	35,358	888	15,625	9,811	244,158
Neck	4,844	1,984	1,812	--	810	720	8,640
Arm	7,012	2,717	2,451	66	751	807	12,246
Wrist	6,567	2,608	2,787	--	712	866	11,962
Hand	1,417	443	403	--	210	87	2,263
Finger, fingernails	849	496	319	--	133	205	1,664
Upper extremities, nec	--	59	--	--	--	--	59
Upper extremities, unspecified	--	--	--	--	--	--	0
Multiple upper extremities	1,085	308	342	--	326	142	1,735
Legs	6,074	4,195	2,426	--	743	969	12,695
Ankles	829	717	320	--	126	460	1,866
Foot	236	382	36		65	48	654
Toes	--	16	--	--	--	--	16
Lower extremities, unspecified	--	--	--	--	--	--	0
Lower extremities, nec	37	--	--	--	--	--	37
Multiple lower extremities	218	61	--		--	--	279
Total all Work-Related MSDs	224,003	56,430	53,149	1,349	21,778	16,292	334,931
Total for Other Body Parts	29,698	8,030	6,843	113	3,304	2,749	44,684
Total Sprains, Strains, Tears	253,701	64,460	59,992	1,462	25,082	19,041	379,615
Percent of Injuries Representing Work-Related MSDs	88	88	89	92	87	86	88

The data summarized above have been broken out by the BLS both by industry sector and by occupation code. In addition, the BLS provided OSHA with estimates of the incidence of MSDs, as defined above by injury type and cause, for each 2-digit SIC. As explained above, the BLS-calculated incidence estimates are based on the incidence among all employees (full-time equivalents) in each industry sector, and therefore understate the true incidence of work-related MSDs occurring among workers who are highly exposed to workplace risk factors, *i.e.,* exposed in jobs that meet the standard's action trigger. Nevertheless, OSHA believes that these incidence estimates are useful for characterizing industry-specific MSD risks and for comparing the extent of the problem between industry sectors covered by the ergonomics program standard. Table VI–5 provides estimates of the number and incidence of LWD MSDs in each general industry 2-digit SIC group for which the BLS provided data. Industries having the highest incidence of MSDs include the following:

Air transportation (36.6 cases/1,000 workers);

Local and suburban transit (14.7 cases/1,000);

Motor freight transportation and warehousing (14.4 cases/1,000);

Health services (13.8 cases/1,000);

Transportation equipment (13.4 cases/1,000); and

Food and kindred products (12.2 cases/1,000).

Table VI–6 provides estimates of the number and incidence of LWD MSDs by occupation code for the 75 occupations having the highest estimated annual incidence of employer-reported MSDs. Because the BLS does not provide incidence estimates by occupation, OSHA calculated the incidence using employment estimates from the Bureau of the Census Employment and Earnings (1996). Occupations having the highest incidence include:

Driver—sales workers (42.4 cases/1,000 workers);

Machine feeders and offbearers (34.6 cases/1,000);

Public transportation attendants (32.1 cases/1,000);

Nursing aides, orderlies, and attendants (31.6 cases/1,000);

Punching and stamping machine operators (30.4 cases/1,000 workers);

Laborers, except construction (29.1 cases/1,000);

Sawing machine operators (18.9 cases/1,000);

Furnace, kiln, and oven operators, except food (18.0 cases/1,000);

Grinding, abrading, polishing machine operators (17.9 cases/1,000);

Health aides, except nurses (16.9 cases/1,000); and

Licensed practical nurses (16.5 cases/1,000).

Table VI-5. Estimated Number of Lost Workday MSDs in 1996 and Annual Incidence per 1,000 Workers, by 2-Digit SIC

Two Digit SIC	Industry Sector	Estimated Number of LWD MSDs	Incidence per 1,000 Workers
45	Transportation by air	34,150.0	36.580
41	Local and suburban transit and interurban highway passinger transportation	4,617.3	14.671
42	Motor freight transportation and warehousing	23,800.1	14.438
80	Health services	103,478.7	13.847
37	Transportation equipment	24,524.0	13.420
20	Food and kindred products	20,540.1	12.242
24	Lumber and wood products, exc. furniture	9,228.5	12.166
34	Fabricated metal, exc. machinery & transportation equipment	17,751.1	12.121
33	Primary metals	8,940.0	12.099
30	Rubber and misc. plastics	11,982.7	12.069
25	Furniture and fixtures	5,892.1	11.741
32	Stone, clay, glass, concrete products	6,316.4	11.444
53	General merchandise stores	22,395.6	11.152
52	Building materials, hardware, garden supply, mobile home dealers	8,621.9	10.699
54	Food stores	25,268.9	10.191
44	Water transportation	1,537.1	9.959
51	Wholesale trade-nondurable goods	24,768.4	9.792
31	Leather and leather products	856.4	9.226
39	Misc. manufacturing industries	3,375.8	8.997
21	Tobacco products	322.9	8.308
70	Hotels, rooming houses, camps, other lodging	11,241.0	8.216
35	Industrial and commercial machinery & computer equipment	17,124.5	7.946
23	Apparel and other finished products made from fabric	6,379.6	7.869
83	Social services	13,755.1	7.483
50	Wholesale trade - durable goods	26,782.1	7.235
57	Home Furniture, Furnishings, And Equipment Stores	6,016.1	7.136
26	Paper and allied products	4,865.2	6.921
07	Agricultural Services	5,187.8	6.861
27	Printing, publishing, and allied industries	9,195.3	6.547
36	Electronic and other electrical, exc. computer equipment	10,782.5	6.506
76	Miscellaneous Repair Services	2,274.4	6.506
49	Electric, Gas, And Sanitary Services	5,712.1	6.478
79	Amusement And Recreation Services	5,805.4	5.857
22	Textile mill products	3,483.4	5.626
59	Miscellaneous Retail	10,043.2	4.857
65	Real Estate	5,882.8	5.113
09	Fishing, Hunting, and Trapping	49.5	4.951
55	Automotive dealers and gasoline service stations	10,347.3	4.847
38	Measuring, analyzing, and controlling instruments; photo, medical, optical; watches, clocks	4,036.9	4.785
75	Automotive Repair, Services, And Parking	4,347.9	4.422
48	Communications	5,708.2	4.398
72	Personal Services	3,527.2	3.865
73	Business services	16,706.8	3.564
28	Chemicals and allied products	3,641.2	3.507
47	Transportation Services	1,263.1	3.262
13	Oil and Gas Extraction	1,075.7	3.170
56	Apparel And Accessory Stores	2,439.1	3.132
29	Petroleum refining and related industries	432.1	2.956
58	Eating and drinking places	14,457.5	2.830
86	Membership Organizations	1,838.5	2.745
82	Educational Services	2,926.6	2.681
87	Engineering, Accounting, Research, Management, And Related Services	5,653.6	2.114
63	Insurance Carriers	2,659.1	2.068
67	Holding And Other Investment Offices	297.6	1.579
81	Legal Services	1,264.4	1.524
60	Depository Institutions	2,487.7	1.355
61	Non-depository Credit Institutions	399.3	0.810
64	Insurance Agents, Brokers, And Service	472.2	0.733
62	Security And Commodity Brokers, Dealers, Exchanges, And Services	276.7	0.533

Source: Estimates provided by BLS (Ex. 26-1413) for disorders classified by injury types and exposure events shown in Table VI-3.

Table VI-6. Estimated Number of Lost Workday MSDs in 1996 and Annual Incidence per 1,000 Workers, by Occupation Code, Ranked by Incidence

Occupation		Estimated Number of LWD MSDs	Median Number of Days Away From Work	Number of Employees in 1996 (000)	Incidence per 1,000 Workers
806	Driver-sales workers (8218)	6,614.0	7	156	42.4
878	Machine feeders and offbearers (8725)	2,420.3	10	70	34.6
463	Public transportation attendants (5257)	3,050.0	9	95	32.1
447	Nursing aides, orderlies, and attendants (5236)	58,421.6	5	1,850	31.6
706	Punching and stamping press machine operators (7314, 7317, 7514, 7517)	2,702.8	6	89	30.4
889	Laborers, except construction (8769)	38,873.3	6	1,334	29.1
727	Sawing machine operators (7433, 7633)	1,470.4	5	78	18.9
766	Furnace, kiln, and oven operators, except food (7675)	1,171.1	7	65	18.0
709	Grinding, abrading, buffing, and polishing machine operators (7322, 7324, 7522)	2,241.8	7	125	17.9
446	Health aides, except nursing (5233)	5,683.3	4	336	16.9
207	Licensed practical nurses (366)	6,514.1	5	395	16.5
785	Assemblers (772, 774)	20,578.8	9	1,271	16.2
804	Truck drivers (8212-8214)	48,334.2	8	3,019	16.0
719	Molding and casting machine operators (7315, 7342, 7515, 7542)	1,757.8	7	110	16.0
869	Construction laborers (871)	12,369.2	7	809	15.3
364	Traffic, shipping, and receiving clerks (4753)	9,244.0	6	616	15.0
368	Weighers, measurers, checkers, and samplers (4756, 4757)	820.4	8	55	14.9
756	Mixing and blending machine operators (7664)	1,585.7	5	108	14.7
449	Maids and housemen (5242, 5249)	9,754.8	6	683	14.3
888	Hand packers and packagers (8761)	3,824.0	10	279	13.7
783	Welders and cutters (7332, 7532, 7714)	7,997.2	6	605	13.2
754	Packaging and filling machine operators (7462, 7662)	5,145.1	8	393	13.1
686	Butchers and meat cutters (6871)	3,120.0	8	242	12.9
206	Radiologic technicians (365)	1,732.4	3	135	12.8
757	Separating, filtering, and clarifying machine operators(7476, 7666, 7676)	725.7	8	57	12.7
877	Stock handlers and baggers (8724)	13,447.8	5	1,106	12.2
544	Millwrights (6178)	1,005.9	15	89	11.3
799	Graders and sorters, except agricultural (785)	1,883.8	8	169	11.1
529	Telephone installers and repairers (6158)	1,952.5	9	176	11.1
769	Slicing and cutting machine operators (7478, 7678)	1,972.6	5	179	11.0
365	Stock and inventory clerks (4754)	5,443.4	8	497	11.0
748	Laundering and dry cleaning machine operators (6855, 7658)	2,207.2	5	202	10.9
507	Bus, truck, and stationary engine mechanics (6112)	3,618.0	5	336	10.8
593	Insulation workers (6465)	567.1	12	54	10.5
683	Electrical and electronic equipment assemblers (6867)	3,368.2	7	325	10.4
444	Miscellaneous food preparation occupations (5219)	6,815.0	11	664	10.3
523	Electronic repairers, communications and industrial equipment (6151, 6153, 615	1,600.1	8	166	9.6

Table VI-6. Estimated Number of Lost Workday MSDs in 1996 and Annual Incidence per 1,000 Workers, by Occupation Code, Ranked by Incidence (continued)

Occupation		Estimated Number of LWD MSDs	Median Number of Days Away From Work	Number of Employees in 1996 (000)	Incidence per 1,000 Workers
759	Painting and paint spraying machine operators (7669)	1,901.2	5	200	9.5
563	Brickmasons and stonemasons (part 6412, part 6413)	1,539.8	10	162	9.5
318	Transportation ticket and reservation agents (4644)	2,869.8	7	304	9.4
516	Heavy equipment mechanics (6117)	1,433.5	14	156	9.2
566	Carpet installers (part 6462)	923.9	12	103	9.0
885	Garage and service station related occupations (873)	1,510.0	9	169	8.9
577	Electrical power installers and repairers (6433)	1,102.3	9	126	8.7
668	Upholsterers (6853)	511.8	7	59	8.7
585	Plumbers, pipefitters, and steamfitters (part 645)	4,742.4	11	555	8.5
439	Kitchen workers, food preparation (5217)	2,063.2	6	257	8.0
573	Drywall installers (6424)	1,317.0	6	168	7.8
567	Carpenters (part 6422)	8,872.2	7	1,220	7.3
268	Sales workers, hardware and building supplies (4353)	1,814.6	6	254	7.1
689	Inspectors, testers, and graders (6881, 828)	925.2	7	131	7.1
595	Roofers (6468)	1,389.2	7	197	7.1
856	Industrial truck and tractor equipment operators (8318)	3,580.6	7	512	7.0
865	Helpers, mechanics, and repairers (863)	801.2	5	115	7.0
453	Janitors and cleaners (5244)	15,278.0	6	2,205	6.9
95	Registered nurses (29)	13,595.2	4	1,986	6.8
344	Billing, posting, and calculating machine operators (4718)	710.1	10	104	6.8
588	Concrete and terrazzo finishers (6463)	543.1	10	80	6.8
653	Sheet metal workers (part 6824)	844.0	5	126	6.7
797	Production testers (783)	380.9	25	57	6.7
744	Textile sewing machine operators (7655)	3,971.1	9	595	6.7
637	Machinists (part 6813)	3,193.3	10	491	6.5
103	Physical therapists (3033)	766.4	5	118	6.5
356	Mail clerks, except postal service (4744)	1,198.4	6	188	6.4
796	Production inspectors, checkers, and examiners (782, 787)	3,404.2	6	538	6.3
518	Industrial machinery repairers (613)	3,407.5	8	540	6.3
738	Winding and twisting machine operators (7451, 7651)	351.3	9	56	6.3
508	Aircraft engine mechanics (6113)	835.4	8	137	6.1
734	Printing press operators (7443, 7643)	1,908.2	9	315	6.1
488	Graders and sorters, agricultural products (5625)	379.1	6	63	6.0
448	Supervisors, cleaning and building service workers (5241)	992.9	5	166	6.0
657	Cabinet makers and bench carpenters (6832)	460.8	9	79	5.8
274	Sales workers, other commodities (4345, 4347, 4354, 4356, 4359, 4362, 4369)	8,616.0	7	1,499	5.7
486	Groundskeepers and gardeners, except farm (5622)	4,981.4	5	875	5.7

Source: Estimates of number of work-related disorders provided by BLS (Ex. 26-1413) for disorders classified by injury types and exposure events shown in Table VII-3. Annual Incidence calculated by OSHA based on 1996 employment data from Emplyment and Earnings (U.S. Bureau of Census, 1996).

Of the Census Employment and Earnings (1996). Occupations having the highest incidence include:

Driver—sales workers (42.2 cases/1,000 workers);

Machine feeders and offbearers (34.6 cases/1,000);

Public transportation attendants (32.1 cases/1,000);

Nursing aides, orderlies, and attendants (31.6 cases/1,000);

Punching and stamping machine operators (30.4 cases/1,000 workers);

Laborers, except construction (29.1 cases/1,000);

Sawing machine operators (18.9 cases/1,000);

Furnace, kiln, and oven operators, except food (18.0 cases/1,000);

Grinding, abrading, polishing machine operators (17.9 cases/1,000);

Health aides, except nurses (16.9 cases/1,000; and

Licensed practical nurses (16.5 cases/1,000).

Of the 225 occupations for which BLS provided estimates of the numbers of employer-reported MSDs and total employment, the annual incidence of MSDs was 1 LWD case or more per 1,000 workers per year for 178 (79 percent) of the occupations. The data described above reflect the annual incidence of MSDs estimated to have occurred in 1996 within general industry sectors and within occupations within this sector.

Past risk assessments conducted by OSHA in other health standards rulemakings have typically estimated the lifetime risk to workers based on the assumption that they are exposed to the hazard in question for a full 45-year working lifetime. These past risk assessments dealt primarily with chronic, fatal diseases such as cancer. Unlike the impairments of health caused by many other OSHA-regulated hazards, however, MSDs are not fatal, although they are often debilitating. Moreover, a worker can experience more than one work-related MSD over a working lifetime. As a result, the lifetime risk associated with exposure to risk factors on the job can be expressed in a number of ways. One way of doing this is to define lifetime risk as the probability that a worker will experience at least one work-related musculoskeletal disorder during his or her working lifetime (45 years). This probability is calculated as $1-(p)^{45}$ where p is the probability that a worker will not experience a work-related MSD in any given year (*i.e.,* p is one minus the estimated MSD incidence for 1996 in the industry sector of interest).[1] For example, the estimated incidence of MSDs in 1996 for SIC 80, Health Services, is 13.847 lost workday cases per 1,000 workers. The probability that a worker in SIC 80 will not experience an MSD in any given year is calculated as 1-.013847, or 0.9862 (almost 99 percent). Over 45 years, the probability that a worker will never experience a work-related MSD is $(.9862)^{45}$, or 0.534 (*i.e.,* 53 percent). Therefore, the probability that a worker in SIC 80 will experience at least one work-related MSD is 1–0.534, or 0.466 (*i.e.,* 466 per 1,000 workers).

Alternatively, lifetime risk could be defined as the expected number of work-related MSDs an employee entering an industry will experience over a working lifetime in that industry. Unlike a probability, the expected value in such cases can exceed 1. (That is why, in the table below, one industry is identified in which an individual who works for 45 years can expect to experience, on average, more than one work-related MSD during that time.) The expected value represents the experience of the ''average'' individual, a measure that reflects the aggregate experience of many individuals.

Both approaches [1] taken by OSHA to estimate lifetime risk assume that the risk to a worker is independent from one year to the next, *i.e.,* that a worker's injury experience in any one year does not modify his or her risk in any subsequent year. Although this is a reasonable assumption for the purpose of estimating an average lifetime risk, it is likely to be the case that the risk will be higher for workers who have had an MSD and continue to be exposed since musculoskeletal tissue has already been damaged. Among workers who have not experienced symptoms of an MSD, the risk to any individual worker in subsequent years depends on the amount of tissue damage sustained from exposure to risk factors and that worker's individual ability to repair or resist continued injury to the point of experiencing an MSD. In addition, OSHA's approach also assumes that each worker within a given industry sector (defined by 2-digit SIC) has the same risk. For the same reasons as discussed above, a relatively small number of workers will, in fact, experience injury rates far in excess of the average, while a comparatively large number will experience injury rates below the average. At this time, data are not available that would allow OSHA to determine the lifetime MSD risks for subpopulations of workers within each industry sector, *i.e.,* those subpopulations with higher than average or lower than average risks, respectively.

Another meaning or interpretation of expected value may be more intuitive: The expected value is the total number of MSDs that may be expected to occur in a cohort of 1000 workers all of whom enter an industry sector at the same time and all of whom work for 45 years in the industry. The expected value of the number of MSDs occurring among these 1,000 workers over 45 years of employment is calculated as the annual MSD incidence multiplied by 45. For example, the estimated incidence of work-related MSDs in 1996 for SIC 80 (Health Services) is 13.847 cases per 1,000 workers, or a frequency of 0.01387. The expected value of the number of work-related MSDs predicted to occur among those 1,000 workers over 45 years is estimated to be (0.01387*45), or 0.623 (623 per 1,000 workers).

Table VI–7 presents OSHA's estimates of the lifetime risk of experiencing work-related MSDs, by industry sector. Based on the probability approach, the estimated probability of experiencing at least one work-related MSD during a working lifetime ranges from 24 per 1,000 to 813 per 1,000, depending on the industry sector. Based on the expected value approach, the expected number of work-related MSDs that will occur in a cohort of workers all entering an industry at the same time ranges from 24 per 1,000 to 1646 per 1,000, since this approach recognizes that it is possible for a worker to experience more than one work-related MSD in a working lifetime.

Several rulemaking participants criticized OSHA's preliminary risk assessment on the grounds that the Agency's risk estimates made no allowance or correction for background risk. These participants (see, for example, Exs. 32–206, 500–223, Tr. pp.10248–9, Exs. 30–3865, 30–3356, 32–368, 30–4185, 30–3813, 30–1722, 500–221) argued that MSD risks for specific industries and occupations based on

[1] OSHA used two simplifying assumptions when calculating the probability of experiencing no work-related MSDs in a working lifetime: (1) Employment in an industry was used as a surrogate for exposure to ergonomic hazards in that industry. (2) The probability of experiencing a work-related MSD in any given industry was treated as if it were identical for workers in that industry who had never previously experienced a work-related MSD and those who had previously experienced a work-related MSD.

[1] In written comments (Ex.32–185–3), the UAW expressed a strong preference for estimating the lifetime risk as the probability that a worker will experience at least one MSD in a working lifetime rather than as an estimate of the lifetime risk expressed as the expected number of MSDs a worker will experience in a working lifetime.

BLS data should be compared to the background rate of MSD risk in the general population to calculate the excess risk associated with work. Some of these stakeholders asserted that, because OSHA has not done so, the Agency's estimates here represent only the average MSD risk posed to a worker in a particular industry or occupation by exposure to ''all of life's activities.'' OSHA does not agree; the BLS data reflect only cases that employers have deemed to be work-related. It would be inappropriate to adjust the MSD rates estimated on the basis of the BLS data by subtracting from these rates the MSD rates that have been reported in the general population. When excess risk is calculated by comparing a population of concern (in this case the employed population) to a reference population (*e.g.,* the general population), the proper approach is to compare the *total* incidence in the population of concern to the *total* incidence in the reference population (see Rothman and Greenland, Ex. 38–240). That is, to estimate the excess risk of MSDs among workers using the approach suggested by these commenters, one must have data that describes the incidence of all MSDs, both work-and non-work-related, in the working population. Assuming that the MSD rate for the general population is the non-work-related rate, and then subtracting this rate from the BLS-based rate, would yield estimates of the work-related, or excess, risk to workers only if the BLS data truly represented all MSDs occurring among workers (both on the job and off the job). This is clearly not the case, since the BLS data are designed only to capture those injuries that are work-related; the BLS system does not capture those MSDs that occur among workers that are unrelated to work. Therefore, adjusting the BLS data by subtracting out MSD rates for the general population would not yield meaningful estimates of the excess MSD risk to workers.

Table VI-7. Estimated Risk of Developing a Work-Related MSDs Over a 45-Year Working Lifetime, by 2-Digit SIC

Two Digit SIC	Industry Sector	Estimated Incidence per 1,000 Workers	Expected Number of MSDs per 1,000 Workers During a Working Lifetime	Number of Workers per 1,000 Estimated to Have at Least One MSD During a Working Lifetime
45	Transportation by air	36.580	1,646	813
41	Local and suburban transit and interurban highway passinger transportation	14.671	660	486
42	Motor freight transportation and warehousing	14.438	650	480
80	Health services	13.847	623	466
37	Transportation equipment	13.420	604	456
20	Food and kindred products	12.242	551	426
24	Lumber and wood products, exc. furniture	12.166	547	424
34	Fabricated metal, exc. machinery & transportation equipment	12.121	545	422
33	Primary metals	12.099	544	422
30	Rubber and misc. plastics	12.069	543	421
25	Furniture and fixtures	11.741	528	412
32	Stone, clay, glass, concrete products	11.444	515	404
53	General merchandise stores	11.152	502	396
52	Building materials, hardware, garden supply, mobile home dealers	10.699	481	384
54	Food stores	10.191	459	369
44	Water transportation	9.959	448	363
51	Wholesale trade-nondurable goods	9.792	441	358
31	Leather and leather products	9.226	415	341
39	Misc. manufacturing industries	8.997	405	334
21	Tobacco products	8.308	374	313
70	Hotels, rooming houses, camps, other lodging	8.216	370	310
35	Industrial and commercial machinery & computer equipment	7.946	358	302
23	Apparel and other finished products made from fabric	7.869	354	299
83	Social services	7.483	337	287
50	Wholesale trade - durable goods	7.235	326	279
57	Home Furniture, Furnishings, And Equipment Stores	7.136	321	275
26	Paper and allied products	6.921	311	268
07	Agricultural Services	6.861	309	266
27	Printing, publishing, and allied industries	6.547	295	256
36	Electronic and other electrical, exc. computer equipment	6.506	293	255
76	Miscellaneous Repair Services	6.506	293	255
49	Electric, Gas, And Sanitary Services	6.478	292	254
79	Amusement And Recreation Services	5.857	264	232
22	Textile mill products	5.626	253	224
59	Miscellaneous Retail	4.857	219	197
65	Real Estate	5.113	230	206
09	Fishing, Hunting, and Trapping	4.951	223	200
55	Automotive dealers and gasoline service stations	4.847	218	196
38	Measuring, analyzing, and controlling instruments; photo, medical, optical; watches, clocks	4.785	215	194
75	Automotive Repair, Services, And Parking	4.422	199	181
48	Communications	4.398	198	180
72	Personal Services	3.865	174	160
73	Business services	3.564	160	148
28	Chemicals and allied products	3.507	158	146
47	Transportation Services	3.262	147	137
13	Oil and Gas Extraction	3.170	143	133
56	Apparel And Accessory Stores	3.132	141	132
29	Petroleum refining and related industries	2.956	133	125
58	Eating and drinking places	2.830	127	120
86	Membership Organizations	2.745	124	116
82	Educational Services	2.681	121	114
87	Engineering, Accounting, Research, Management, And Related Services	2.114	95	91
63	Insurance Carriers	2.068	93	89
67	Holding And Other Investment Offices	1.579	71	69
81	Legal Services	1.524	69	66
60	Depository Institutions	1.355	61	59
61	Non-depository Credit Institutions	0.810	36	36
64	Insurance Agents, Brokers, And Service	0.733	33	32
62	Security And Commodity Brokers, Dealers, Exchanges, And Services	0.533	24	24

Source: Estimated Incidence of MSDs provided by BLS for disorders classified by injury and exposure events shown in Table VI-5. Lifetime risk estimates calculated by OSHA using methods described in the text.

Some commenters (see, *e.g.*, Ex. 30–3813, Tr. 4102–4108, Exs. 30–3356, 30–46–28, 30–4564, 30–3865, 30–4185, 30–3368, 30–1897) argued that, despite screening out some of the background risk, the BLS data are still overinclusive.

They pointed out that under the applicable OSHA and BLS guidelines, a case is considered ''work-related'' if an event or exposure in the workplace made *any* contribution to the injury or illness, regardless of the extent of that contribution. For example, Frank White of ORC testified that

> ORC [and others] question OSHA's ability to make quantitative determinations of workplace risks based on data that do not allow OSHA to differentiate between the respective contributions of workplace and non-workplace factors. In the face of OSHA's own acknowledgment of the special difficulties associated with establishing MSD causation compared ''to more traditional workplace exposures and disorders,'' the use of data that inherently include conditions caused by both work and non-work exposures to determine workplace risk is unacceptable. The result, once again, is an overreaching by OSHA—this time in its estimation of the true workplace risk—that has the effect of permeating, and effectively invalidating, the entire proposal. (Tr. 4102)

OSHA interprets Mr. White's comment as saying that, although strictly non-work-related MSDs are not captured by the BLS system, some proportion of cases in the system nevertheless represent MSDs that occur among workers who are not regularly exposed to risk factors, or whose exposures arise from tasks that are not ''core elements'' of the job (using the language contained in the proposed rule). In other words, although there may be some contribution from work to these cases, exposure to risk factors on the job are no greater that those encountered during non-work activities.

In this risk assessment for the final ergonomics program standard, OSHA has relied on BLS injury and illness data in much the same way it does when evaluating the risks associated with safety hazards. Because the statistics relied upon by OSHA reflect work-related injuries and illnesses reported by employers and determined by OSHA to have been associated with exposure to the risk factors addressed by the final rule, there is no ''background'' number of injuries and illnesses in the OSHA data in the sense that BLS data are capturing non-work-related injuries. In other words, the total number of MSDs that occur in the workforce are either work-related or non-work-related; BLS counts the first and the second represents background. Thus, OSHA does not agree with these commenters that it is necessary to adjust the BLS data *per se* to account for such background risk.

However, OSHA does recognize that some fraction of the number of MSDs estimated from the BLS data represents injuries and illnesses occurring among employees in jobs that would not be covered by the OSHA standard. That is, some of the MSDs being captured by the BLS's annual survey reflect injuries to workers who are not in jobs that meet the action trigger, *e.g.,* those who may be exposed to risk factors only infrequently or those whose exposures were not of sufficient duration. OSHA does not intend the final ergonomics program standard to apply to these kinds of jobs. Instead, OSHA intends the standard to apply to those jobs where MSDs have occurred and the employee's exposure to risk factors was of sufficient duration, magnitude, and frequency to have contributed to the injury. This concept is reflected in the final rule in the form of the Basic Screening Tool, which explicitly identifies those exposure conditions that must be present on the job, along with an employee's report of an MSD incident, before the employer is obligated to implement the program. Employers have no obligation to establish an ergonomics program under the final rule if employees are not exposed to risk factors at least at the level(s) reflected in the Basic Screening Tool. Thus, OSHA adjusted, as an alternate analysis, its estimates of risk based on the BLS data to include only that portion of the risk that will be addressed by an ergonomics program developed under the final rule, *i.e.,* that portion of the risk that is occurring among employees who are exposed to risk factors at least to the extent reflected in the final rule's screening tool. OSHA is thus estimating the risk of MSDs occurring among employees who would be covered in an ergonomics program, *i.e.,* those who are more highly exposed to biomechanical risk factors.

As explained by OSHA above, the BLS-reported incidence of MSDs reflects the number of MSDs reported per 1,000 full-time equivalent workers employed in industry. This incidence figure distributes the MSDs evenly across all workers in an industry sector or occupation. However, as demonstrated by the scientific evidence presented in the Health Effects section (Section V), OSHA has determined that the work-related risk of MSDs increases with the intensity and/or duration of exposure. Because of this, MSDs are not, in fact, evenly distributed across all workers, but are concentrated among the proportion of workers who are the more highly exposed to biomechanical risk factors. Thus, the incidence of MSDs among the more highly exposed workers is greater than that among the lesser-exposed workers; this has been shown in the almost 200 epidemiological studies reviewed in the Health Effects section. It is for this reason that OSHA believes that the risk estimates presented in the first analysis above, which relied on the BLS-reported incidence estimates by industry and occupation, understate the true risk among the workers who are more highly exposed to physical risk factors (while overstating it for workers who are not highly exposed to risk factors).

OSHA's second approach to estimating work-related MSD risks takes account of this risk differential between more highly exposed (*i.e.,* higher-risk) workers and lesser-exposed (*i.e.,* lesser-risk) workers to estimate more precisely the risk among those workers who would most benefit from an ergonomics program. In addition, the risk among the higher-risk workers is estimated in two forms. One assumes that all of the risk among the higher-risk workers can be attributed to their exposure to biomechanical risk factors, *i.e.,* all of the risk is work-related. OSHA believes this is reasonable because the data used to make these estimates are the BLS data, which represents MSDs reported by employers to be work-related. The second form assumes that, despite the fact that the data derive from reports of work-related injuries, only part of the risk can be attributed to workplace exposure to physical risk factors because of the presence of some ''background'' risk among the higher-risk workers. This background risk represents MSDs that are not work-related and are attributed to some unknown non-work exposure to risk factors. OSHA believes that making such an adjustment to the estimated risk among higher-risk workers leads to an overly conservative estimate of risk among workers whose jobs will be screened in under the final rule; however, the Agency is nevertheless making this adjustment in response to addresses the concerns of those commenters who argued that OSHA should take account of the ''background'' incidence of MSDs.

The first step in OSHA's second approach to estimating work-related MSD risks is to estimate the incidence of MSDs for higher-risk and for lesser-risk workers. OSHA considers the higher-risk workers to be those workers who are exposed to risk factors at levels that meet the final rule's basic screening tool; all other workers are considered lower-risk in the sense that they are exposed to risk factors at levels below the final rule's screen.

To accomplish this analysis, OSHA relied on data contained in the record from Washington State's industry-wide survey of workplace exposure to physical risk factors (Ex. 500–41–118); details of this survey are presented in Chapter 3 (Benefits Assessment) of the Final Economic Analysis. Data from this survey were used to estimate the percentage of employees in each major industry group who are exposed to risk factors that at least meet the level of a ''caution zone'' job under Washington State's ergonomics standard. The kinds and durations of risk factor exposures contained in Washington State's definition of a ''caution zone'' job are similar to those contained in OSHA's Basic Screening Tool, *e.g.,* generally 2 or more hours per shift of exposure to repetitive motions, awkward postures, contact stress, or segmental vibration, or 4 or more hours per shift of keyboarding activity. Both tools also use the same lifting weight and frequency-of-lift criteria to screen jobs for force associated with manual handling. Because of the similarities between OSHA's screening tool and the Washington State criteria, OSHA believes it reasonable that use of the Washington State survey data on workplace exposures to biomechanical risk factors will yield reasonable estimates of the numbers of workers who are exposed to risk factors at the levels that meet the action trigger of the final rule. OSHA has used these data, along with data derived from the epidemiology studies reviewed in the Health Effects section (Section V of the final rule's preamble), to estimate the number and incidence of MSDs occurring annually among employees who are exposed to risk factors at levels meeting the action trigger in the final rule. OSHA's Final Economic Analysis contains a detailed description of the Washington State survey data and OSHA's use of these data to estimate the percentage of workers in each covered industry sector who are exposed to risk factors at levels that meet the final rule's action trigger.

OSHA's approach to estimating the excess risk of MSDs among exposed workers is summarized in Table VI–8. From the Washington State survey data, OSHA estimated the percentage of employees who are exposed to risk factors that meet the final rule's screen criteria (Column D of Table VI–8) in each 2-digit industry sector, as well as the number of higher-risk workers (Column E).

To estimate the incidence of MSDs separately for higher-risk as compared with lower-risk workers, OSHA assumes that the annual incidence of MSDs among the higher-risk workers is three times that of low-risk workers. The justification for this assumption can be found in the many epidemiology studies reviewed in the Health Effects section of this preamble (Section V). These studies compared the prevalence or incidence of MSDs among workers who are regularly exposed to the risk factors addressed by the final rule with the prevalence or incidence among the referent (or less-exposed) worker populations. Typically, these epidemiological studies report observed differences in these rates as ratios (such as odds ratios, incidence ratios, prevalence ratios, or other relative risk measures). A compilation of the risk measures identified in these studies appears in the form of estimated median and mean risk ratios in Table VI–9, separated by part of body. As the table shows, median risk ratios for back disorders, neck and shoulder disorders, and upper extremity disorders are 1.85, 2.7 to 3.3, and 2.8 to 6.6, respectively. Mean values for back disorders, neck and shoulder disorders, and upper extremity disorders are 2.4, 4.5 to 5.2, and 4.4 to 12.6, respectively. Based on these values, OSHA finds that, in general, employees who are regularly exposed to the risk factors covered by the final rule are at three times higher risk or, put another way, will experience a 3-fold higher incidence of MSDs than is the case for workers who are not so exposed.

Table VI-8 Approach for Estimating Excess Risk of MSDs Among Workers Exposed to Risk Factors That Meet the Final Rule's Screen

	A	B	C	D	E	F	G	H	I
SIC	Total No. LWD MSDs[a]	Incidence per 1,000 Workers[b]	Estimated No. Full-Time-Equivalent Workers in SIC[c]	Percent of Workers in Jobs > Screen[d]	Estimated No. of Higher-Risk Workers[e]	Incidence Among Higher-Risk Workers (Pd)[f]	Incidence Among Non-Lower-Risk Workers (Po)[g]	Potentially Preventable Risk Among Higher-Risk Workers (per 1,000) (High Estimate)[h]	Potentially Preventable Risk Among Higher-Risk Workers (per 1,000) (Low Estimate)[i]
07[j]	3,890.0	6.906	563,279	43.20%	243,337	0.01111	0.00370	11.115	7.437
08[j]	144.0	6.738	21,372	43.20%	9,233	0.01084	0.00361	10.844	7.256
09	49.5	4.951	9,998	43.20%	4,319	0.00797	0.00266	7.968	5.326
13	1,075.7	3.170	339,338	43.20%	146,594	0.00510	0.00170	5.102	3.407
20	20,540.1	12.242	1,677,839	43.00%	721,471	0.01975	0.00658	19.745	13.251
21	322.9	8.308	38,866	43.00%	16,712	0.01340	0.00447	13.400	8.973
22	3,483.4	5.626	619,161	43.00%	266,239	0.00907	0.00302	9.074	6.068
23	6,379.6	7.869	810,726	43.00%	348,612	0.01269	0.00423	12.692	8.497
24	9,228.5	12.166	758,548	43.00%	326,176	0.01962	0.00654	19.623	13.168
25	5,892.1	11.741	501,840	43.00%	215,791	0.01894	0.00631	18.937	12.705
26	4,865.2	6.921	702,962	43.00%	302,274	0.01116	0.00372	11.163	7.470
27	9,195.3	6.547	1,404,506	43.00%	603,938	0.01056	0.00352	10.560	7.065
28	3,641.2	3.507	1,038,266	43.00%	446,455	0.00566	0.00189	5.656	3.778
29	432.1	2.956	146,177	43.00%	62,856	0.00477	0.00159	4.768	3.184
30	11,982.7	12.069	992,849	43.00%	426,925	0.01947	0.00649	19.466	13.062
31	856.4	9.226	92,825	43.00%	39,915	0.01488	0.00496	14.881	9.970
32	6,316.4	11.444	551,940	43.00%	237,334	0.01846	0.00615	18.458	12.382
33	8,940.0	12.099	738,904	43.00%	317,729	0.01951	0.00650	19.515	13.095
34	17,751.1	12.121	1,464,491	43.00%	629,731	0.01955	0.00652	19.550	13.119
35	17,124.5	7.946	2,155,109	43.00%	926,697	0.01282	0.00427	12.816	8.581
36	10,782.5	6.506	1,657,316	43.00%	712,646	0.01049	0.00350	10.494	7.020
37[j]	22,581.0	15.866	1,423,274	43.00%	612,008	0.02559	0.00853	25.590	17.206
38	4,036.9	4.785	843,657	43.00%	362,773	0.00772	0.00257	7.718	5.158
39	3,375.8	8.997	375,214	43.00%	161,342	0.01451	0.00484	14.511	9.721
41	4,617.3	14.671	314,723	47.60%	149,808	0.02255	0.00752	22.548	15.146
42	23,800.1	14.438	1,648,435	47.60%	784,655	0.02219	0.00740	22.190	14.903
44	1,537.1	9.959	154,343	47.60%	73,467	0.01531	0.00510	15.306	10.256
45	34,150.0	36.580	933,570	47.60%	444,379	0.05622	0.01874	56.219	38.195
46[j]	194.0	12.878	15,065	47.60%	7,171	0.01979	0.00660	19.791	13.282
47	1,263.1	3.262	387,216	47.60%	184,315	0.00501	0.00167	5.013	3.348
48	5,708.2	4.398	1,297,908	47.60%	617,804	0.00676	0.00225	6.759	4.516
49	5,712.1	6.478	881,769	47.60%	419,722	0.00996	0.00332	9.956	6.659

Table VI-8 Approach for Estimating Excess Risk of MSDs Among Workers Exposed to Risk Factors That Meet the Final Rule's Screen (Continued)

SIC	A Total No. LWD MSDs[a]	B Incidence per 1,000 Workers[b]	C Estimated No. Full-Time-Equivalent Workers in SIC[c]	D Percent of Workers in Jobs > Screen[d]	E Estimated No. of Higher-Risk Workers[e]	F Incidence Among Higher-Risk Workers (Pd)[f]	G Incidence Among Non-Lower-Risk Workers (Po)[g]	H Potentially Preventable Risk Among Higher-Risk Workers (per 1,000) (High Estimate)[h]	I Potentially Preventable Risk Among Higher-Risk Workers (per 1,000) (Low Estimate)[i]
50	26,782.1	7.235	3,701,742	42.70%	1,580,644	0.01171	0.00390	11.707	7.835
51	24,768.4	9.792	2,529,453	42.70%	1,080,076	0.01584	0.00528	15.845	10.619
52	8,621.9	10.699	805,860	35.10%	282,857	0.01886	0.00629	18.858	12.652
53	22,395.6	11.152	2,008,214	35.10%	704,883	0.01966	0.00655	19.657	13.191
54	25,268.9	10.191	2,479,531	35.10%	870,315	0.01796	0.00599	17.963	12.047
55	10,347.3	4.847	2,134,784	35.10%	749,309	0.00854	0.00285	8.543	5.712
56	2,439.1	3.132	778,768	35.10%	273,347	0.00552	0.00184	5.521	3.687
57	6,016.1	7.136	843,063	35.10%	295,915	0.01258	0.00419	12.578	8.421
58	14,457.5	2.830	5,108,657	35.10%	1,793,139	0.00499	0.00166	4.988	3.331
59	10,043.2	4.857	2,067,778	35.10%	725,790	0.00856	0.00285	8.561	5.724
60	2,487.7	1.355	1,835,941	21.00%	385,548	0.00286	0.00095	2.863	1.910
61	399.3	0.810	492,963	21.00%	103,522	0.00171	0.00057	1.711	1.141
62	276.7	0.533	519,137	21.00%	109,019	0.00113	0.00038	1.126	0.751
63	2,659.1	2.068	1,285,832	21.00%	270,025	0.00437	0.00146	4.369	2.917
64	472.2	0.733	644,202	21.00%	135,282	0.00155	0.00052	1.549	1.033
65	5,882.8	5.113	1,150,557	21.00%	241,617	0.01080	0.00360	10.802	7.227
67	297.6	1.579	188,474	21.00%	39,579	0.00334	0.00111	3.336	2.226
70	11,241.0	8.216	1,368,184	36.60%	500,755	0.01423	0.00474	14.231	9.533
72	3,527.2	3.865	912,600	36.60%	334,012	0.00669	0.00223	6.695	4.473
73	16,706.8	3.564	4,687,654	36.60%	1,715,681	0.00617	0.00206	6.173	4.124
75	4,347.9	4.422	983,243	36.60%	359,867	0.00766	0.00255	7.659	5.119
76	2,274.4	6.506	349,585	36.60%	127,948	0.01127	0.00376	11.269	7.541
78[j]	3,614.0	7.072	511,031	36.60%	187,037	0.01225	0.00408	12.249	8.200
79	5,805.4	5.857	991,190	36.60%	362,776	0.01014	0.00338	10.145	6.786
80	103,478.7	13.847	7,473,005	36.60%	2,735,120	0.02398	0.00799	23.984	16.118
81	1,264.4	1.524	829,659	36.60%	303,655	0.00264	0.00088	2.640	1.761
82	2,926.6	2.681	1,091,608	36.60%	399,528	0.00464	0.00155	4.644	3.101
83	13,755.1	7.483	1,838,180	36.60%	672,774	0.01296	0.00432	12.961	8.678
84[j]	319.0	3.994	79,862	36.60%	29,229	0.00692	0.00231	6.919	4.623
86	1,838.5	2.745	669,763	36.60%	245,133	0.00475	0.00158	4.755	3.175
87	5,653.6	2.114	2,674,361	36.60%	978,816	0.00366	0.00122	3.662	2.444
89[j]	761.0	7.193	105,803	36.60%	38,724	0.01246	0.00415	12.458	8.340
TOTAL	590,998		77,702,172		29,454,352				

[a, b] OSHA estimates based on 1996 BLS data (Ex. 26-1413).

[c] (Col A/Col B) * 1000

[d] Data from Washington State Industry Survey, see Chapter 4 of Final Economic Analysis.

[e] Col C * Col D

[f] (Col B)/[Col D + ((1-Col D)/3)], see Chapter 4 of Final Economic Analysis for derivation.

[g] [Col A - (Col E * Col F)]/(Col C - Col E)

[h] Col F * 1000

[i] (Col F - Col G)/(1 - Col G)

[j] Estimated number of MSDs represents the sum of estimates for industry sectors at the 3-digit SIC level to exclude industry sectors not covered in the final rule and to include include data for industry sectors for which BLS did not provide an estimate at the 2-digit SIC level. Estimates of the numbers of MSDs and employees are taken from Chapter 2 (Industry Profile) of the Final Economic Analysis

Assuming that there is a three-fold higher risk of MSDs among higher-risk workers compared with lower-risk workers, the incidence of MSDs among higher-risk employees is estimated for each industry sector by the following formula:

$$\frac{MSDInc_{tot}}{Pct_E - \left[(1 - Pct_E)/RR\right]}$$

where:

$MSDInc_{tot}$ is the MSD incidence among all workers in the industry sector;

Pct_E is the percentage of workers in the industry sector who are considered to be regularly exposed to risk factors at levels that meet the final rule's screen; and

RR is the risk ratio of 3.

The derivation of this formula appears in Chapter 3 (Benefits) of OSHA's Final Economic Analysis.

TABLE VI–9.—SUMMARY OF RISK RATIOS IN THE EPIDEMIOLOGICAL LITERATURE FOR MSDS REVIEWED BY OSHA, AND ESTIMATED FRACTION OF MSDS ATTRIBUTABLE TO WORKPLACE EXPOSURE

	Body part affected/disorder							
	Neck or neck/ shoulder	Only shoulder	Elbow	Carpal tunnel syndrome	Hand/wrist tendinitis	Hand/arm vibration	Back	Lower extremity
Number of Studies Included ..	42	32	18	30	10	12	44	9
Risk Ratios [a]								
Median	2.7	3.3	2.8	3.2	3.7	6.6	1.85	2.2
Average	4.5	5.2	5.5	4.4	6.5	12.6	2.66	2.4
Estimated Percent of MSDs Attributable to Exposure to Risk Factors [b]								
Median	63.0	69.5	63.6	68.5	72.6	84.8	45.9	53.5
Average	77.6	80.6	81.9	77.5	84.6	92.1	62.4	58.9

[a] Risk ratios include odds ratios, prevalence rate ratios, and incidence ratios.

[b] Proportion of disorders among exposed workers that is attributable to their exposure at work; calculated as (RR–1)/RR, where RR is the median or average risk ratio derived from each group of epidemiological studies.

Source: Data presented in Tables V–1 through V–6 of the Health Effects section (Section V).

The MSD incidence among lower-risk employees in each industry sector is estimated as the ratio of the number of MSDs that occurred in 1996 among lower-risk employees to the estimated number of lower-risk employees in each industry sector (see formula in Table VI–8).

The portion of the risk for higher-risk employees that can be attributed directly to workplace exposure to risk factors (*i.e.,* that portion of the risk that is potentially preventable) lies between two extremes, the upper and the lower bound of the range of estimated risks. OSHA estimated the upper bound of the range to be equal to the MSD incidence among higher-risk employees; this bound assumes that the BLS data includes no cases reflecting background risk, since all of the MSD cases in the BLS data are work-related. The lower bound, on the other hand, assumes that the MSD incidence among lower-risk employees is entirely attributable to background, *i.e.,* that work did not contribute in any of the MSD cases reported among lower-risk workers. To estimate the lower bound, OSHA estimated the excess risk among higher-risk workers from the general formula that the Agency has used in previous risk assessments to estimate excess risk. The general formula for estimating excess risk is

$$\frac{P_d - P_0}{1 - P_0}$$

where P_d is the probability of injury or illness among workers exposed to a hazard and P_0 is the background risk that occurs among persons who are not exposed to the hazard. In this case, P_0 represents the estimated MSD incidence among workers who are either not exposed to risk factors at work or who are exposed to risk factors below the level meeting the final rule's screen.

As with the first risk assessment approach discussed above, OSHA also estimated the lifetime risk of experiencing a LWD MSD to workers who work in jobs that meet the final rule's basic screening tool. Estimates representing the risk of experiencing at least one MSD and the average number of MSDs per worker (*i.e.,* the expected value) were calculated assuming a 45-year working life. Table VI–10 presents OSHA's estimates of the lifetime risk of experiencing work-related MSDs, by industry sector; lifetime risks were calculated based on both the upper- and lower-bound estimates of the MSD incidence among higher-risk employees (*i.e.,* those exposed to risk factors at levels meeting the final rule's screen). Based on the probability approach, the estimated probability that a higher-risk worker will experience at least one work-related MSD during a working lifetime ranges from 33 per 1,000 workers to 926 per 1,000 workers, depending on the industry sector. Based on the expected value approach, the expected number of work-related MSDs that will occur in a cohort of higher-risk workers all entering an industry at the same time ranges from 34 per 1,000 workers to 2,530 per 1,000 workers, since this approach recognizes that it is possible for a worker to experience more than one work-related MSD in a working lifetime.

Table VI-10. Estimated Excess Risk of Developing a Work-Related MSDs Over a 45-Year Working Lifetime Among Employees Exposed to Risk Factors In Excess of the Final Rule's Screen (Adjusted for Background)

Two Digit SIC	Industry Sector	Estimated Number of LWD MSDs Among High-Risk Workers	Estimated Excess Risk per 1,000 Workers		Expected Number of MSDs per 1,000 Workers During a Working Lifetime		Number of Workers per 1,000 to have at Least One MSD During a Working Lifetime	
			High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate
45	Transportation By Air	24,982.7	56.219	38.195	2,530	1,719	926	827
37	Transportation Equipment	15,661.0	25.59	17.206	1,152	774	689	542
80	Health Services	65,600.2	23.984	16.118	1,079	725	665	519
41	Local and Suburban Transit and Interurban Highway Passinger Transportation	3,377.8	22.548	15.146	1,015	682	642	497
42	Motor freight Transportation and Warehousing	17,411.1	22.19	14.903	999	671	636	491
46	Pipelines, Except Natural Gas	141.9	19.791	13.282	891	598	593	452
20	Food and Kindred Products	14,245.6	19.745	13.251	889	596	592	451
53	General Merchandise Stores	13,855.8	19.657	13.191	885	594	591	450
24	Lumber and Wood Products, Exc. Furniture	6,400.4	19.623	13.168	883	593	590	449
34	Fabricated Metal, Exc. Machinery & Transportation Equipment	12,311.2	19.55	13.119	880	590	589	448
33	Primary Metals	6,200.3	19.515	13.095	878	589	588	447
30	Rubber and Misc. Plastics	8,310.6	19.466	13.062	876	588	587	447
25	Furniture and Fixtures	4,086.5	18.937	12.705	852	572	577	438
52	Building Materials, Hardware, Garden Supply, Mobile Home Dealers	5,334.2	18.858	12.652	849	569	575	436
32	Stone, Clay, Glass, Concrete Products	4,380.7	18.458	12.382	831	557	568	429
54	Food Stores	15,633.5	17.963	12.047	808	542	558	420
51	Wholesale Trade-Nondurable Goods	17,113.4	15.845	10.619	713	478	513	381
44	Water Transportation	1,124.5	15.306	10.256	689	462	500	371
31	Leather and Leather Products	594.0	14.881	9.970	670	449	491	363
39	Misc. Manufacturing Industries	2,341.3	14.511	9.721	653	437	482	356
70	Hotels, Rooming Houses, Camps, Other Lodging	7,126.2	14.231	9.533	640	429	475	350
21	Tobacco Products	223.9	13.4	8.973	603	404	455	333
83	Social Services	8,720.0	12.961	8.678	583	391	444	324
35	Industrial and Commercial Machinery & Computer Equipment	11,876.7	12.816	8.581	577	386	440	321
23	Apparel and Other Finished Products Made From Fabric	4,424.6	12.692	8.497	571	382	437	319
57	Home Furniture, Furnishings, And Equipment Stores	3,722.1	12.578	8.421	566	379	434	317
89	Services, Not Elsewhere Classified	482.4	12.458	8.340	561	375	431	314
78	Motion Pictures	2,291.1	12.249	8.200	551	369	426	310
50	Wholesale Trade - Durable Goods	18,504.8	11.707	7.835	527	353	411	298
76	Miscellaneous Repair Services	1,441.9	11.269	7.541	507	339	399	289
26	Paper and Allied Products	3,374.3	11.163	7.470	502	336	397	286
7	Agricultural Services	2,704.6	11.115	7.437	500	335	395	285
8	Forestry	100.1	10.844	7.256	844	327	388	279
65	Real Estate	2,610.0	10.802	7.227	486	325	387	278
27	Printing, Publishing, and Allied Industries	6,277.4	10.56	7.065	475	318	380	273

Table VI-10. Estimated Excess Risk of Developing a Work-Related MSDs Over a 45-Year Working Lifetime Among Employees Exposed to Risk Factors In Excess of the Final Rule's Screen (Adjusted for Background)

Two Digit SIC	Industry Sector	Estimated Number of LWD MSDs Among High-Risk Workers	Estimated Excess Risk per 1,000 Workers		Expected Number of MSDs per 1,000 Workers During a Working Lifetime		Number of Workers per 1,000 to have at Least One MSD During a Working Lifetime	
			High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate
36	Electronic and Other Electrical, Exc. Computer Equipment	7,478.2	10.494	7.020	472	316	378	272
79	Amusement and Recreation Services	3,680.3	10.145	6.786	475	305	368	264
49	Electric, Gas, and Sanitary Services	4,178.7	9.956	6.659	448	300	363	260
22	Textile Mill Products	2,415.9	9.074	6.068	408	273	336	240
59	Miscellaneous Retail	6,213.6	8.561	5.724	385	258	320	227
55	Automotive Dealers and Gasoline Service Stations	6,401.7	8.543	5.712	384	257	320	227
9	Fishing, Hunting, and Trapping	34.4	7.968	5.326	359	240	302	214
38	Measuring, Analyzing, and Controlling Instruments; Photo, Medical, Optical; Watches, Clocks	2,799.8	7.718	5.158	347	232	394	208
75	Automotive Repair, Services, and Parking	2,756.3	7.659	5.119	345	230	292	206
84	Museums, Art Galleries, and Botanical and Zoological Gardens	202.2	6.919	4.623	311	208	268	188
48	Communications	4,175.9	6.759	4.516	304	203	263	184
72	Personal Services	2,236.1	6.695	4.473	301	201	261	183
73	Business Services	10,591.3	6.173	4.124	278	186	243	170
28	Chemicals and Allied Products	2,525.3	5.656	3.778	255	170	225	157
56	Apparel and Accessory Stores	1,509.0	5.521	3.687	248	166	221	153
13	Oil and Gas Extraction	747.9	5.102	3.407	230	153	206	142
47	Transportation Services	924.0	5.013	3.348	226	151	202	140
58	Eating and Drinking Places	8,944.6	4.988	3.331	224	150	202	139
29	Petroleum Refining and Related Industries	299.7	4.768	3.184	215	143	194	134
86	Membership Organizations	1,165.5	4.755	3.175	214	143	193	133
82	Educational Services	1,855.3	4.644	3.101	209	140	189	130
63	Insurance Carriers	1,179.7	4.369	2.917	197	131	179	123
87	Engineering, Accounting, Research, Management, And Related Services	3,584.1	3.662	2.444	165	110	152	104
67	Holding And Other Investment Offices	132.0	3.336	2.226	150	100	140	95
60	Depository Institutions	1,103.7	2.863	1.910	129	86	121	82
81	Legal Services	801.6	2.64	1.761	119	79	112	76
61	Non-depository Credit Institutions	177.2	1.711	1.141	77	51	74	50
64	Insurance Agents, Brokers, And Service	209.5	1.549	1.033	70	46	67	45
62	Security And Commodity Brokers, Dealers, Exchanges, And Services	122.8	1.126	0.751	51	34	49	33
	TOTAL	389,118						

Source: Estimated Incidence of MSDs provided by BLS for disorders classified by injury and exposure events shown in Table VI-3. Lifetime risk estimates calculated by OSHA using methods described in the text.

Several rulemaking participants commented on the results of OSHA's preliminary risk assessment and the approaches taken by the Agency to estimate the magnitude of MSD risks to employees.

In their post-hearing submissions (Exs. 500–221, 500–223), Keller & Heckman presented an alternative risk analysis that they believe could be used to compare work-related risks to the background risk of MSDs. Citing the work of Maizlish *et al.* (Ex. 26–1186), they stated that the background risk of carpal tunnel syndrome (CTS) is 1.05 cases per 1,000 person-years; this estimate is based on an analysis of medical records in Rochester, Minnesota, between 1961 and 1980 (Stevens *et al.,* Ex. 26–1009). Using OSHA's estimates from the preliminary risk assessment of the total number of MSDs in U.S. industry for each of the six injury categories selected by OSHA, Keller & Heckman estimated a background incidence for each of the six injury types based on the ratio of the number of LWD cases for each injury type to the number of LWD CTS cases. For example, since OSHA's estimates of the number of LWD strains, sprains, and tears is 16.88 times higher than the number of LWD CTS cases, Keller & Heckman estimated that the background rate of LWD strain, sprain, and tear injuries in the U.S. population is 17.72 cases per 1,000 people per year (*i.e.,* 16.88×1.05). Across all six injury types, Keller & Heckman estimated the background rate for all LWD MSDs to be 22.83 cases per 1,000 persons per year for the U.S. population. They also estimated the MSD rate across the U.S. workforce to be 6.55 LWD MSD cases per person-year, by dividing the total estimated number of MSDs in 1996 (647,344) by private industry employment for 1996 (98,772,900 workers). From this analysis, Keller & Heckman concluded that there is no significant excess risk of MSDs in private industry, since the estimated background rate of MSDs in the *general* population is about 3.5 times higher than the rate that they estimated for the U.S. workforce. They presented similar estimates of MSD rates for selected industry sectors at the 3-digit SIC level and concluded that (1) only 10 of the hundreds of industry sectors covered by the ergonomics program rule have an MSD incidence that exceeds their estimated background rate of MSDs, and (2) that there is no excess risk of work-related MSDs in either SIC 204 (Grain Mill Products), SIC 206 (Sugar and Confectionary Products), or SIC 331 (Steel Works, Blast Furnaces, and Rolling Mills).

OSHA believes that the analysis conducted by Keller & Heckman is seriously flawed in a number of respects. First, Keller & Heckman make an improper comparison between estimated MSD rates in the working population, based on the BLS data, and estimated MSD rates in the *general* population, based on community medical records for the rate of CTS in Rochester, Minnesota. As explained in part B above, the BLS injury and illness survey is not designed to capture all injuries and illnesses that occur among workers; it is only designed to capture those that employers have determined to be work-related. In contrast, the Rochester study on which Keller & Heckman's analysis rests involved *all* cases of CTS that occurred in the community, regardless of whether those cases were work-related or not. These two statistics are not comparable in any meaningful way. To make a meaningful comparison, one would need to have data that permit estimates to be made of the *total* MSD rate in the U.S. workforce, not just the work-related component.

Second, Keller & Heckman assume that the ratio between the number of one type of MSD to that of another will mirror the ratio of the incidence rates for the two types of MSDs in the general population. However, the ratio between the number of cases of two medical conditions can be equal to the ratio of the incidences of those conditions *only* if the cases of both medical conditions are drawn from the *same* population. Clearly, the population from which the BLS data are drawn differs from the general U.S. population in many ways. Consequently, OSHA believes that it is not possible to reliably estimate the background rate of any type of MSD in the general population from the ratio between two MSD types seen in the working population, and therefore the assumption made by Keller & Heckman in conducting their analysis is not supportable.

Third, Keller & Heckman's analysis interprets the rate of CTS in the Rochester, Minnesota, population as the ''background'' rate of CTS. However, the study by Stevens *et al.* (Ex. 26–1009) made no effort to evaluate the work-relatedness of the CTS cases identified from the medical records, nor was there any mention of the investigators collecting work histories or assessing the work status of the cases identified. The Maizlish study (Ex. 26–1186) cited by Keller & Heckman was a study of a California surveillance system for work-related CTS, in which the Rochester CTS rate was used as a reference point for the purpose of identifying ''epidemic clusters'' of CTS (defined as a rate twice that of the Rochester CTS rate). Although the authors of this study refer to the Rochester CTS rate as a ''background'' rate, their rate is clearly not a background rate as that term is used in occupational epidemiology. It cannot represent the rate of CTS among persons without workplace exposure because the CTS cases in the Maizlish study were drawn from the entire Rochester population, which included both workers and non-workers.

For these reasons, OSHA finds the analysis provided by Keller & Heckman both methodologically flawed and unconvincing. The Agency believes that its own risk analysis, which is based on estimates of the numbers of higher-risk and lower-risk workers and on the extensive epidemiological data presented in Section V of this preamble, appropriately takes account of that portion of the MSD rate among workers that is attributable to their workplace exposures.

Keller & Heckman (Exs. 500–221, 500–223) also claim that the ''aggregate risk (workplace and non-workplace risk combined)'' of a U.S. worker experiencing an LWD MSD due to anything that might be defined as a harmful physical agent would be no more than 0.7 per 1,000 workers per year. They arrive at this rate by dividing the 1996 number of BLS MSD cases caused by repetition by total private industry employment. This estimate ignores the LWD cases attributed in the BLS data to overexertion or to awkward postures (*i.e.,* ''bending, climbing, crawling, reaching, twisting''), both of which are exposure event codes that OSHA has determined to be highly relevant for assessing MSD risks to workers. Second, Keller & Heckman characterize their aggregate risk rate as reflecting both workplace and non-workplace contributions to MSD risk. Since the rate Keller & Heckman use is derived from BLS data, which reflects work-related cases exclusively, OSHA does not agree with this characterization.

The National Coalition on Ergonomics (Ex. 32–368) and the American Iron and Steel Institute (Ex. 32–206) objected to the fact that OSHA did not modify its risk estimates from the BLS data by reducing them to account for MSDs that occurred in jobs that would not pass the screening criteria in § 1920.902 of the proposal. In the final ergonomics program rule, OSHA has modified its screening criteria from the performance-oriented language contained in the proposal to be more specific in terms of the kinds and durations of exposures to risk factors that warrant further hazard analysis by the employer. Employers are not expected to conduct job hazard analysis or provide medical management of MSDs for employees in jobs where the exposures to risk factors are below those in the final rule's action trigger. As described above, OSHA has now modified its risk assessment to estimate the number and incidence of MSDs that occur each year among workers who are in jobs in which exposures meet the action trigger. Thus, OSHA's final risk assessment reflects the excess MSD risks among the more highly exposed portion of the worker population covered by the standard.

The Center for Office Technology (COT) (Ex. 30–2208) and the Puerto Rico Manufacturing Association (Ex. 30–3348) took issue with OSHA's statements in the preliminary risk assessment and significance of risk analysis for the proposed rule that the BLS data understate risk. For example, COT commented that

> * * * BLS in their reports state that there is ''95% confidence that the 'true' incidence rate falls within the confidence interval * * * and has an estimated relative standard error of about 0.9 percent.'' BLS does not state that their estimates of injury and illnesses reflect under reporting. Assistant Secretary Charles Jeffress is also on the record supporting the accuracy of the BLS data and is quoted * * * as saying ''90% of employers keep accurate records 95% of the time, or better.'' (Ex. 2208, p. 19)

However, OSHA did not base its preliminary determination that work-related MSDs are seriously underreported on the precision (or lack thereof) of the BLS survey. The BLS statement referred to in COT's comment simply reflects the fact that the BLS estimates of work-related injuries and illnesses in the United States are based on a sampling of OSHA 200 logs, not the logs of all employers. Consequently, the estimates generated from the sample of logs have some uncertainty associated with them, which is characterized by a 95% confidence interval around the estimate. The stated precision of the survey data provided by the BLS does not address issues related to the accuracy of the logs that are sampled, just the precision of the *estimates* generated from the sampled logs. OSHA's determination that MSDs are seriously underreported on OSHA logs is based on the findings of several scientific studies and other data that compared MSD rates from logs to those from medical insurance records, records of sick leave, or other sources of data independent from the OSHA logs; these studies were reviewed in Table VII–2 of the preamble to OSHA's proposed rule (64 FR 65982), and in Table VII–1 and OSHA's discussion of the Significance of Risk (Section VII) in this preamble.

According to NIOSH (Ex. 32–450), OSHA's discussion of the limitations on the use of BLS data in the risk assessment section of the preamble is methodologically sound. These limitations include the following characteristics of reported cases:

- The cases reported are only those that employers have agreed are work-related,
- The cases reported are only those that were serious enough to involve at least one day away from work,
- The cases reported do not include other types of work-related MSD cases that rarely, if ever, come to the attention of the employer, and
- The cases reported do not account for the extended or permanent disability that results in employee termination.

In addition, NIOSH points out that some workers with MSD episodes that may represent lost workday cases are reassigned to minimal work activities in order to avoid recording the case as one involving lost workdays. For these reasons, NIOSH agrees that there is a substantial likelihood of under-reporting in the BLS system and that the BLS estimates represent a lower bound of the true risks of work-related MSDs. NIOSH agrees with OSHA that the true incidence of work-related MSDs is greater than indicated by the BLS estimates.

In its pre-hearing comments (Ex. 32–368), the National Coalition on Ergonomics objected to the use of BLS data in risk assessment on the grounds that the data reflect reports by workers to employers rather than medical diagnoses. The BLS data relied on by OSHA in this risk assessment is lost-work-day data, which employers provide to the BLS along with sufficient information about each injury or illness to permit detailed classification of each injury and illness. Thus, the data relied on by OSHA do not represent ''reports by workers to employers'' but cases that employers have determined to be work related and for which they provided detailed descriptions of the nature of the events associated with each case. Further, the Coalition's comment implies that MSD rates would be much lower if they were based on medical diagnoses rather than employer reports. However, evidence in the rulemaking record shows that the opposite result is more likely; several investigators have actually compared MSD rates from the OSHA logs with the rates reflected in other sources of data that report the results of medical evaluations of injuries and illnesses, such as medical insurance records, compensation claims, medical case records, and medical absence records (Exs. 26–28, 26–920, 26–1261, 26–1259, 26–1260). These studies, reviewed in the Significance of Risk section of the preamble (Section VII), have consistently found the MSD rates reported on OSHA logs to be several-fold lower than those derived from medical records data. Thus, OSHA believes that a risk analysis based on accurate reports of the medical diagnoses of work-related MSDs would result in higher risk estimates than those in OSHA's analysis.

The Edison Electric Institute (Ex. 32–300–1) and Southern California Edison (Ex. 30–3284) take OSHA's statement in the preliminary risk assessment that BLS data ''are not easy to use for risk assessment purposes'' to mean that these data are weak. This is not the case nor is it what OSHA meant by this statement. OSHA's statement that the BLS data are not easy to use for risk assessment referred to the fact that the BLS injury and illness classification system does not contain a single injury/illness category that contains data on all relevant MSDs. This fact required the Agency to select injury/illness categories and appropriate exposure event categories to represent the kinds of disorders addressed by the final rule. As discussed above, OSHA has determined both that the BLS data are the best available data for evaluating MSD risks to workers and that OSHA's reliance on these data is appropriate. In addition, these two stakeholders characterize the employment estimates from the U.S. Bureau of the Census as ''another questionable data source'' without providing any justification for this characterization. They also stated that combining these data to calculate MSD rates by occupation ''compounds the flaw.'' In fact, both the BLS and Bureau of Census population data have been used by the Agency to analyze the impact of its rules for several years, are used extensively by other researchers both within and outside the federal government, and represent state-of-the-art programs for conducting and analyzing nationwide surveys of working populations. OSHA knows of no other data sources that could provide more reliable information on occupations and workplace injuries and illness in the United States.

Jesse McDaniel, a Certified Safety Professional from August Mack Inc. (Ex. 30–240), commented on OSHA's use of the BLS data and the preliminary risk assessment. First, Mr. McDaniel stated that injuries that do not involve lost workdays, restricted work, or medical treatment (or diagnosis in the case of an illness) are not recordable cases under OSHA's recordkeeping rules; he believes that OSHA was therefore incorrect in stating in the preliminary risk assessment that the BLS data understate the true MSD risk to workers because it excludes cases that do not involve days away from work. In other words, Mr. McDaniel appears to believe that cases not counted as LWD MSDs in the BLS system are not recordable, and that OSHA's claim that the data understate the true risk is not warranted. OSHA does not agree it was incorrect in making this statement. The data relied on by OSHA for both its preliminary and final risk assessment comes from the detailed employer survey data, which requires employers to provide descriptions of work-related injuries and illnesses only for those cases involving days away from work, *i.e.,* the employer is not required to provide detailed information on other kinds of recordable injuries and illness not involving days away from work. Therefore, OSHA's estimates of LWD MSD rates based on the BLS data do not include the other kinds of recordable MSDs referred to by Mr. McDaniel. He also believes that OSHA inflated its risk estimates by reporting MSD rates per 1,000 workers rather than on a per-100-worker basis, which is the convention used by BLS in reporting injury rates by industry sector and occupation. OSHA used the risk per 1,000 worker metric because OSHA's significant risk range is bounded by the Supreme Court's guidance in the *Benzene* decision, as explained in the preliminary risk assessment. Mr. McDaniel also provided examples that he believes suggest OSHA's estimated LWD MSD rates exceed the BLS-estimated total injury case rates for some industry sectors and occupations. However, since the BLS case rates are reported per 100 full-time-equivalent employees, and OSHA presents its risk estimates conventionally in terms of cases per 1,000 employees, OSHA's rates, as they appear in this risk assessment, must first be divided by 10 to be comparable to the BLS injury case rates. When this adjustment is made, the comparisons made by Mr. McDaniel show that OSHA's estimated MSD rates are *below* the BLS's total injury case rates.

D. Analysis of Ergonomic Program Effectiveness

In the preliminary risk assessment, OSHA evaluated information and data that described the effectiveness of ergonomic interventions and programs similar to those of the proposed ergonomics program standard [64 FR 65943–65975]. These data were drawn from three sources. First, OSHA searched for and evaluated studies that investigated the effect of ergonomic interventions on reducing exposures to workplace risk factors. These included both field and laboratory studies. Second, OSHA compiled a large database of published and unpublished data from case studies that describe the effect of implementing ergonomic programs on workplace MSD injury rates. Finally, OSHA used the findings from the epidemiological studies contained in the NIOSH (1997, Ex. 26–1) review to estimate the potential effectiveness of ergonomics programs. Since publication of the proposal, a substantial number of additional scientific and ergonomic case studies were entered into the record; OSHA has relied on these to revise its effectiveness analysis. The additional information and data entered into the record confirm OSHA's preliminary determination in the proposal that ergonomic programs and interventions are effective both in reducing those forces on the musculoskeletal tissue that have been associated with the development of tissue pathology, and in reducing the incidence of MSDs. In this section, OSHA summarizes these studies and evidence and analyzes the data from these studies to estimate the overall reduction in MSD rates that is likely to occur when employers implement ergonomic programs like the program required by this standard.

The record contains much testimony from scientific experts that ergonomic programs designed to reduce biomechanical load are effective in reducing MSD risk. In its pre-hearing testimony, NIOSH agreed with OSHA's preliminary conclusion that ergonomic programs are effective:

> * * * [T]here are numerous companies which have reported success in using ergonomic programs as a cost-effective way to prevent or reduce work-related MSDs, and reduce lost time by workers with MSDs. Some of these companies also report increases in productivity and workplace morale. The studies—in part summarized in OSHA's preamble, reviewed by the NAS panel—illustrate that interventions, including redesign of tools, machines, and work stations, can reduce workplace hazards and the resulting MSDs. * * *
>
> The effectiveness of ergonomics programs was a resounding message echoed by labor, industry, business, universities, health care, and professional societies at two conferences co-organized by NIOSH and OSHA to stimulate an exchange of information about preventing work-related MSDs. * * * The conferences, attended by over 1,700 people, featured workshops and presentations by industry, labor, and government representatives sharing their successful ergonomics programs and how they have reduced lost work time and cut costs due to injuries and illnesses in a variety of industries and workplaces. * * *
>
> NIOSH believes that the evidence in the scientific literature showing the success of an ergonomics program approach to workplace hazards is strong. Likewise, NIOSH's experience in evaluating the risks of MSDs in a variety of workplaces and our review of information from a variety of sizes of industries has generally shown that using ergonomic programs is an effective way to prevent or reduce work-related MSDs.

(Ex. 32–450–1, pp. 8–10)

Many expert witnesses also testified that, from their experience, ergonomic programs are effective in reducing MSD risks. For example, Dr. Snook testified on the effectiveness of ergonomic programs for reducing the disability from back pain:

> Now, this is what we know about ergonomics and low back disorders. First of all, we know that in heavy manual handling jobs, there is an increased disability from low back pain, as measured in lost work days and restricted duty.
>
> The second thing that we know is that there have been several guidelines developed to help identify the high risk manual handling jobs.
>
> Third, that when these jobs are designed according to the guidelines, the disability from low back pain decreases.
>
> And finally, employers who have used ergonomics programs to identify and control high-risk jobs have found them to be cost effective.
>
> I also believe it is important to acknowledge what we do not know. We simply do not know the * * * [etiology] or the cause of most low back pain.
>
> Some have suggested that this lack of knowledge must constitute a stopping point. Others, however, have demonstrated that this is not a stopping point, that implementing ergonomic intervention[s] and programs to reduce physical loads does reduce the disability from low back pain.

(Tr. 846–847)

Dr. Cherniak testified that the volume of published ergonomics literature itself is indicative of the success of ergonomics interventions:

> The extensive literature review included in this [OSHA's proposed] standard and explosion of the ergonomics literature in industrial countries are testaments to the seriousness of MSDs, but also to the effectiveness of responsive intervention. I would say that medical fields that lack components of prevention and therapeutics do not usually generate expanding literature. They generally lead to dead ends.

(Tr. 1134–1135)

Many other rulemaking participants provided testimony that ergonomics programs reduce disease. Dr. Barbara Silverstein, Research Director for the Safety and Health Assessment and Research Team, Washington State Department of Labor and Industries, testified that ''Reducing exposure to hazardous loads does reduce musculoskeletal disorder prevalence, incidence, and severity.'' (Tr. 17357) Both Drs. Bernacki and McCunney, representing the American College of Occupational and Environmental Medicine, testified that ergonomics programs instituted at their respective universities were very effective in reducing MSD rates and severity. (Tr. 7690–7693) Sherri Gibson, representing the American Industrial Hygiene Association, testified that ''We know the controls and ergonomic programs work, we've seen it time and time again.'' (Tr. 16466) Under questioning by OSHA, Mr. Fernandez, a practicing ergonomist, stated that, although some ergonomic interventions may require more than one attempt and some ''tweaking,'' in his experience he has never seen a case in which an ergonomic intervention or program was ultimately unsuccessful. (Tr. 5427)

In the preliminary risk assessment that accompanied the proposed rule, OSHA relied, in part, on the large body of epidemiological data showing consistent associations between exposure to biomechanical factors at work and an increased prevalence or incidence of MSDs. Although these studies were not designed specifically to determine or measure the effectiveness of ergonomic interventions in working populations studied, OSHA finds that they nonetheless provide highly useful information on the potential for ergonomic interventions to reduce injuries and illnesses; these studies provide this information because they describe the relationship between exposure to the biomechanical risk factors addressed in this final ergonomics program rule and the risk to workers of developing MSDs. The Health Effects section (Section V of the preamble) summarizes the results of more than 170 epidemiological studies overall, more than 60 of which demonstrate that increased MSD risk is related to increased duration and/or magnitude of exposure to biomechanical risk factors. Other biomechanical and biological data reviewed in the Health Effects section provide evidence that excessive force imposed on musculoskeletal tissue, absent sufficient repair and recovery time, is associated with tissue damage that is consistent with the kinds of disorders seen in the working populations studied; thus, this supporting evidence is consistent with the general model that excessive biomechanical loading increases the risk of developing MSDs. At the public hearings, OSHA presented much expert scientific testimony that this general model is supported by high-quality scientific evidence. Although there is evidence that other factors, including individual and non-biomechanical workplace factors (*e.g.,* psychosocial factors), also influence risk, the evidence shows that work-related biomechanical factors act independently of these other factors in increasing MSD risk.

Because of the independent relationship between biomechanical and other risk factors in the etiology of MSDs, a change in worker exposure to biomechanical risk factors would be expected to lead to a corresponding change in worker risk of MSDs. One of the basic principles of public health is that reducing exposure to a substance, agent, or force that has been demonstrated to be harmful to health will reduce the risk of harm; this principle has been the scientific rationale behind all of OSHA's substance-specific health standards. Accordingly, OSHA finds that the strong evidence in the scientific literature relating exposure to biomechanical risk factors to an increased risk of MSDs is, by itself, sufficient evidence for Agency action that will reduce the exposure of workers to biomechanical factors in the workplace. OSHA's determination is supported by the testimony of its witnesses. In his written testimony, Dr. Wells stated that the epidemiological studies involving biomechanical risk factors have found strong and consistent relationships between those risk factors and MSDs, and therefore that reducing exposures to these risk factors is a reasonable strategy for preventing MSDs (Ex. 37–18). Similarly, Dr. Frank commented that the epidemiological evidence and the results of other investigations on the biology of low back pain strongly suggest that reductions in forces exerted on the spine will substantially reduce disability (Ex. 37–27). During questioning at the public hearing, Dr. Frank explained:

> * * * [A]cting on biomechanical risk factors will bring risk reductions according to our understanding of the multifactorial causal process even if we are unable, for example, at the present time to conclusively act to reduce psychosocial factors because we still understand them poorly.
>
> Q: So that given that as a conclusion, then in your opinion does that mean that an OSHA standard aimed at reducing exposure to biomechanical factors in the work place is likely to reduce lost time disability for low back pain?
>
> Dr. Frank: That is what every epidemiologist who understands these methods would say.

Dr. Punnett also explained the importance of findings that biomechanical risk factors act independently from other factors and the implication of those findings on intervention strategies:

> Q: What is so important about this finding that the physical job factors causing MSD are independent of any of these other factors?
>
> Dr. Punnett: Well, that I think leads us fairly directly to the inference that reducing physical work load all other things being equal will reduce the magnitude and/or severity of musculoskeletal disorders. * * * That is that the effect is not confounded by those other factors. And therefore, we can anticipate a benefit proportional to the increase that has been identified with current exposures.
>
> Q: Does this mean that an OSHA standard aimed at reducing exposure to MSD hazards [*i.e.,* biomechanical factors] is likely to prevent work-related MSDs?
>
> Dr. Punnett: I believe so, yes.

Table VI–8 presented summary statistics from the epidemiological studies that OSHA selected for the Health Effects section; these studies include those contained in the 1997 NIOSH review (Ex. 26–1) as well as additional studies in the record. The statistics presented in Table VI–8 include the range in risk ratios reported in these studies, grouped by type of disorder studied, as well as the median and mean of the distribution of these risk ratios. The risk measures in the epidemiological studies include odds ratios, prevalence rate ratios, and (for a few studies) incidence ratios, and approximate the relative risk of musculoskeletal disorders in an exposed worker population compared with that in a referent group. Although the risk ratios reported in epidemiological studies cannot be used directly to measure the effectiveness of ergonomics programs, they do provide information on that part of the MSD incidence seen in workers that can be attributed directly to their exposure to biomechanical risk factors; this portion of the MSD incidence is termed the attributable, or etiologic fraction, and is also the fraction of the MSD incidence seen in worker populations that is potentially preventable.

The concept of an attributable or etiologic fraction is standard in epidemiology, and the concept has been used previously to estimate the attributable fraction of several types of MSDs in working populations. Hagberg and Wegman (1987, Ex. 26–32) reviewed the epidemiological literature and selected 21 studies in which diagnoses of neck and shoulder disorders were made from physical or laboratory examinations. Odds ratio measures from studies describing similar disorders were pooled across studies for common occupations that involved exposures to workplace risk factors, and the authors computed the overall odds ratio for each type of occupation and disorder. In addition, the authors assessed the effect of the exposure to workplace risk factors on MSD risk by computing the etiological fraction in the exposed population; the etiologic fraction was computed only from those odds ratios that were statistically significantly higher than 1. Hagberg and Wegman (1987, Ex. 26–32) found that the etiological fraction ranged from 40 to 99 percent, depending on the specific type of upper extremity disorder. This study thus provides evidence that the potential for ergonomic interventions to reduce MSD incidence among workers is quite high, provided that such interventions reduce worker exposures to biomechanical risk factors.

OSHA's own summary of the risk ratios reported in the epidemiological database, both in the preliminary and final risk assessments, is consistent with the findings of Hagberg and Wegman (Ex. 26–32). The distribution of risk ratios reported in the epidemiology studies relied on by OSHA in the Health Effects section of the preamble indicate that, based on the median of the distribution, between 46 percent (back disorders) and 88 percent (hand-arm vibration syndrome (HAVS)) of the MSDs experienced by workers who have substantial exposure to biomechanical risk factors (*i.e.,* those workers who comprised the exposed cohorts in these studies) can be attributed to their exposure to risk factors, and are therefore potentially preventable by reducing exposure to the biomechanical risk factors that caused them. For upper extremity disorders (excluding HAVS), neck disorders, and shoulder disorders, the attributable fractions based on the median of the risk ratios is between 55 and 65 percent. The mean of the distribution suggests a somewhat higher attributable fraction: 58 percent for back disorders, 93 percent for HAVS, and between 70 and 80 percent for all others.

As discussed above, OSHA has determined that the strength of the epidemiological, biomechanical, and biological data reviewed in the Health Effects section is sufficient to justify the promulgation of an ergonomics program standard to reduce the significant risks of MSDs posed to workers who are exposed to biomechanical risk factors on the job. Nevertheless, the record contains a substantial body of scientific evidence and case reports that demonstrate directly that ergonomic programs designed to reduce exposures to biomechanical risk factors *do* reduce the incidence of MSDs in exposed workers. Some of this evidence was reviewed in the preliminary risk assessment for the proposed rule; however, since publication of the proposal, many additional studies and case reports have been made available in the record. The remainder of this part of OSHA's final risk assessment reviews these studies and reports.

Intervention studies that employ formal scientific methods are particularly compelling and merit special attention. Unfortunately, intervention studies for ergonomics programs are infrequently conducted because they are complex and scientifically challenging because of the lack of control that investigators generally have over workplace conditions. Thirty-four reports of ergonomic interventions in workplaces were identified in the rulemaking record and are summarized in Table VI–11. Each of these 34 reports was characterized by:

- A clearly described intervention,
- Measurable exposure or health effects endpoints
- Acceptable statistical methods, and
- Characterization of exposure or health outcomes both prior to and after intervention.

These 34 studies together represent the best available direct evidence that practical application of the principles and methods of ergonomics in the workplace results in reduced employee exposure to hazards and in a reduced incidence of work-related musculoskeletal disorders. These studies evaluated the effect of ergonomic interventions on risk factor exposure, health outcomes, or both. Of these studies, 22 reported that, after the ergonomic intervention, exposure was reduced, as measured by the magnitude of external stressors (*i.e.*, reductions in repetitions or improved postures) or reduced tissue loading; 12 of these studies also documented reduced MSD rates as measured by injury records or employee symptom reports. OSHA believes that the 12 studies that measured both exposure and outcome effects are particularly strong, and their findings particularly significant, because they provide direct evidence of a relationship between reductions in exposure to biomechanical risk factors and reductions in the incidence of MSD cases or symptoms, findings that are consistent with the model derived from the epidemiological data, which posits that biomechanical risk factors are associated with an increased MSD risk independent of other contributing factors. Ten of the intervention studies documented outcome measures alone and found that injury rates or symptom reports declined following ergonomic interventions. Two studies (Bernacki, 1999, Ex. 38–34; Bohr, 1997, Ex. 38–64) also reported improved recognition of potentially hazardous jobs among the participants in the ergonomics programs studied.

TABLE VI–11.—SUMMARY OF SCIENTIFIC STUDIES DESIGNED TO ASSESS THE EFFECTIVENESS OF ERGONOMIC INTERVENTIONS

Study	Population	Intervention	Analytic method	Exposure outcome	Health effects outcome
Aaras (1994) Ex. 502–252; Westgaard (1985) Ex. 26–787; Westgaard (1984) Ex. 26–1026.	420 female telecommunication assembly workers.	Reduce postural load: individual adjustment of workstation height and angle, increased legroom, suspending hand tools, arm supports, limit vertical dimensions; Design work to reduce postural fixity.	Longitudinal survival analysis (1967–1984). Exposure evaluated by trapezius static load via EMG, postural angles Outcome: signs & symptoms, sick leave due to load-related MSDs. Survival analysis.	Decreased postural load intensity and duration on trapezius, reduce load in hand, reduced shoulder angles.	Reduction in mean sick leave from 22 days to 1.8 days, Reduced turnover from 30.1% to 7.6%, Increased productivity.

TABLE VI–11.—SUMMARY OF SCIENTIFIC STUDIES DESIGNED TO ASSESS THE EFFECTIVENESS OF ERGONOMIC INTERVENTIONS—Continued

Study	Population	Intervention	Analytic method	Exposure outcome	Health effects outcome
Aaras (1997) Ex. 26–63.	20 VDU workers	Forearm support, screen sight angle change.	Laboratory study using open, randomized Graeco-Latin squared trial with five test conditions using keyboard and then using mouse, measurements included descending m. trapezius and erector spinae lumbalis at L3 EMG and inclinometer.	Trapezius load significantly lower with forearm support (both duration and intensity) with both sitting and standing. No significant differences with 15 versus 30 degrees sightline.	
Aaras (1998) Ex. 26–597.	Male VDU workers, 50 per group.	1 new lighting .... 2 new workplace design to support forearms. 3 optical exams and corrections.	Serial interventions in 2 intervention groups, 1 control group, Load measured via EMG and observation, controlled for psychosocial factors at work and home.	Reduced trapezius load in intervention groups after forearm support and optometric corrections, Reduced glare problems in intervention groups.	Reduced trapezius pain, in intervention groups, no change in forearm pain (appeared to be associated with increased mouse use, no change in back pain). Headaches reduced after lighting change, borderline improvement with optometry, Visual discomfort improved with both lighting and optometry
Bernacki (1999) (Ex. 38–34).	University employees, 1992–1998.	Implementation of a program with early diagnosis and treatment, ergonomic assessment and correction: wrist supports, document holders, foot rests, headsets, alternate keyboards, glare screens, chairs, etc.	Longitudinal follow-up of employees reporting to the medical department after policy to include medical workup and ergonomic assessments for UEMSDs starting in 1992. OSHA 200 logs.	Ergonomic assessments (2041), initially with those with UEMSDs for job modifications. By 1994, significantly more assessments on jobs believed to be risky prior to injury.	Incidence rate decreased 80% (6.5 in 1992 to 1.3/1000 in 1998), surgery trend also decreased.
Bohr (1997) Ex. 38–64	600 employees in three departments in a large metropolitan medical center.	Used participatory worker-management ergonomics teams to identify risks and control strategies.	One year longitudinal evaluation of the ability of ergonomic teams to identify problems and design solutions.	14 problems identified and potential solutions considered or identified.	not assessed.
Brission 1999 Ex. 38–92.	627 university employees working 5 or more hours per week with a video display unit.	Ergonomic training to identify postural stressors and make changes in equipment and work activities.	Six month longitudinal comparison of postural stressors and injury statistics in randomly assigned experimental (n=284) and control (n=343) groups.	Greater decreases in the prevalence of three postural stressors in the experimental group than the control group.	Greater decrease in the prevalence of musculoskelatal disorders by both questionnaire and physical exam in experimental group subjects under 40 years of age than in the control group.

TABLE VI–11.—SUMMARY OF SCIENTIFIC STUDIES DESIGNED TO ASSESS THE EFFECTIVENESS OF ERGONOMIC INTERVENTIONS—Continued

Study	Population	Intervention	Analytic method	Exposure outcome	Health effects outcome
Cook (1999) Ex. 38–205.	20 meatpackers	Clamp rather than hand to hold hog head while chiseling. Modified handle and tool balance for ham trimming, Air knife to cut casings rather than pulling casings by hand.	RMS EMG measurements if biceps, extrinsic finger and wrist flexor muscles after calibration. Workers randomized order of trials between old and new method by each worker for 30 minutes (multiple A–B–A–B research design).	Left wrist and finger flexor muscle effort was significantly reduced in chiseling operation (hand holding eliminated). Right wrist and finger flexor muscle effort significantly reduced in ham trimming. Casing pulling task showed no significant reduction in muscle effort.	
Drury & Wick (1984) Ex. 26–1244; Wick (1987) Ex. 26–1058.	Shoe manufacturing workers.	Ergonomics program including employee training and involvement in developing controls, systematic process of task analysis, design, testing, implementation and measurement. Tilted work surfaces, arm & foot rests, adjustable chair, pneumatic pedal, pallet leveller.	Pre-post study design. Observational analysis of posture, force, frequency every half hour for week pre and post intervention, postural discomfort survey, performance measures Data for 5 jobs presented.	Prototype implementation showed productivity increased or remained unchanged, awkward wrist motions decreased, postural stress ratings decreased.	Body area discomfort eliminated (except forearm). Two year follow-up of ornament job (Wick) showed no additional injuries reported.
Evanoff (1999) Ex. 38–32.	100–110 orderlies in a 1,200 bed urban hospital.	Used a participatory worker-management ergonomics committee to design and implement changes in training and work practices for lifting.	Two year longitudinal evaluation of pre and post intervention injury rates and self reports of symptoms.	Not reported	Decreased OSHA recordable injury and lost workday rates (relative risk = 0.64 for all injuries and 0.4 for lost time injuries among orderlies, adjusted for rates among other hospital staff. Statistically significant reductions in reports of various systems.
Garg (1999)	Seven nursing homes and one hospital, employing 57–136 nursing personnel each.	Used Participatory employee-management advisory teams to implement ‘‘zero-lift programs’’.	One year longitudinal comparison of pre and post intervention injury statistics.	Not reported	For injuries from patient transfers: 62% decrease in the number of injuries, 86% decrease in lost workdays, 64% decrease in restricted workdays, 84% decrease in workers’ compensation costs.

TABLE VI–11.—SUMMARY OF SCIENTIFIC STUDIES DESIGNED TO ASSESS THE EFFECTIVENESS OF ERGONOMIC INTERVENTIONS—Continued

Study	Population	Intervention	Analytic method	Exposure outcome	Health effects outcome
Garg & Owen (1992) Ex.–1093 (1994) Ex. 502–481; Owen & Garg (1994) Ex. 26–1415.	57 nursing assistants in 2 nursing home units.	Walking belts and mechanical hoists, shower chairs.	Pre-post study design: observed transfer techniques, rate of perceived exertion, OSHA 200 logs 4 years prior to intervention and 4 months post intervention.	Significant reduced perceived exertion with mechanical and belt transfers compared to manual transfers. Mechanical lifts with scales and shower chairs reduced the number of transfers required per patient.	Back injury incidence rate decreased from 83 to 42 per 100 FTEs, Severity rate decreased from 634 days to 0 days per 100 FTEs [Note: short follow-up time reduces strength of the study. There was an increased in injury/severity rate in the first phase of the intervention on one unit, but none of thee injuries were related to resident transfers]
Harms-Ringdahl Ex. 26–630.	71 Electronic circuit board assembly workers.	Suspended arms support to reduce neck and shoulder muscle static loading.	Pre-post intervention design. Symptoms (VAS) 12 months and one week prior to intervention, and 3 months (n=31) and monthly ratings for 1.5 years post intervention (n=71).	Not reported	31 subjects per-3 months post shoulder symptoms decreased from 62% to 45%, for neck decreased from 57% to 55%. Mean end of shift VAS in 1.5 year follow-up decreased from 46mm to 24mm, and for neck 41mm to 19mm. 93% of subjects using the balancers after 1.5 years. [Note: paired analysis was not used at 1.5 years].
Jones (1997) Ex. 32–339–1–29.	12,000 employees in 13 poultry processing plants.	Comprehensive corporate-wide ergonomics program, including management commitment, ergonomic committees, risk factor checklists, job analysis, medical management, education and training, and job modification.	Five year longitudinal evaluation of workers' compensation rates and costs and overall program assessment scores..	Not reported	46% and 20% decrease in UEMSD incidence rate and severity rate, respectively. 50% and 36% decrease in lifting claims incidence rate and severity rate respectively.
Kadefors (1996)	Auto assembly workers in the assembly versus parallel assembly.	Increase task variability, increase cycle time, increase standing upright.	Comparsion of factories with and without parallel assembly and tilting car capacity using observational analysis and EMG.	Reduced time in awkward postures in each assembly step when using tilting device, lower muscle load with tilt assembly, reduced discomfort.	Not described; small sample size in pre-full production phase limits conclusions.
Loisel, (1997) Ex. 38–28.	130 employees from various workplaces, absent from work for more than four weeks with back pain.	Either occupational (including ergonomic) or clinical intervention, separately and in combination.	Population based randomized clinical trail with three intervention groups and one control group.	Not reported	The occupational and the combined intervention groups returned to regular work 1.5 and 2.4 times faster than those in the usual care intervention group or the clinical intervention group.

TABLE VI–11.—SUMMARY OF SCIENTIFIC STUDIES DESIGNED TO ASSESS THE EFFECTIVENESS OF ERGONOMIC INTERVENTIONS—Continued

Study	Population	Intervention	Analytic method	Exposure outcome	Health effects outcome
Marklin & Wilzbacker (1999).	Electric utility warehouse workers.	(a) Raise location of heavy objects from below knee to thigh height. (b) Replace heavy oak gate with lighter pine gate. (c) Modify tool with extension and better drill bit. (d) Maintenance of pulling system. (e) Height adjustable lift table for handling meter readers. (f) Semiautomated pallet wrap machine. (g) Power tool for opening line clamps.	Pre-post intervention assessment of exposure in jobs with historically high injury rates using NIOSH lifting equation, 3D Static Strength Prediction Program, Lumbar Motion Monitor and Perceived Exertion.	Reduced lifting index (a&b), Increased percentage of population capable (c & d), Reduction in probability of back injury reduced (e & f), Reduction in perceived exertion (g).	Not reported.
McKenzie (1985)	6,600 Telecommunications manufacturing workers.	Ergonomics program with taskforce, training for engineers and supervisors, improved workstation and tools, medical management of restricted workers.	Pre-post program design using OSHA 200 logs for repetitive trauma disorder cases, lost and restricted days. Program was implemented in 1981.	Not reported	Dramatic decrease in number of cases, lost and restricted days. Authors attribute much of the improvement in lost and restricted days to better medical management.
Melhorn (1996) Ex. 38–19.	212 rivet gun employees.	Random assignment to various combinations of posture training, exercise training and rivet gun types.	Longitudinal evaluation of risk factors among eight exposure groups compared with controls.	Decreased risk associated with ergonomic posture training. Vibration dampening rivet guns associated with decreased risk among new hires and increased risk among previous hires.	Not assessed.
Melhorn (1999) Ex. 38–131.	3152 newly hired sheet metal mechanics.	Comprehensive program of education, job placement, modifications and medical management designed for employees based on individualized risk assessments.	Prospective cohort evaluation with pre and post intervention comparisons.	Not reported.	Increased recordable case incident rate and hours worked per employee. Decreased lost time case incident rate, lost time severity rate, and workers' compensation costs per employee. Benefit to cost ratio of 16.5/1.0.
Meyers *et al.*(1999)	194 Wine grape harvest workers in 3 vineyards.	Substitute smaller tubs to lower weight to below 50 pounds.	Participatory ergonomics intervention study addressing load weight and hand coupling. Used checklist to identify tasks and lumbar motion monitor and NIOSH Lifting Equation to assess physical load, symptoms questionnaires and OSHA logs to assess health.	Reduced tub weight from 57 to 47 pounds.	Results not reported.

TABLE VI–11.—SUMMARY OF SCIENTIFIC STUDIES DESIGNED TO ASSESS THE EFFECTIVENESS OF ERGONOMIC INTERVENTIONS—Continued

Study	Population	Intervention	Analytic method	Exposure outcome	Health effects outcome
Miller (1971) Ex. 26–1250.	Surgeons and scrub nurses.	Added larger surface area to handle of surgical forceps to increase stability and decrease load on fingers.	Pre-post testing of extensors and flexors with EMG over 35 procedures by six surgeons.	Reduced fatigue and required recovery time.	Not applicable.
Moore (1994) Ex. 38–339–1–35.	5 engine assembly workers.	Participatory ergonomics approach: eliminate carrying 11.6–14.7 kg parts, eliminate high impact use of brass head hammers.	Pre-post case study of one job. OSHA 200 log incidence data (39 months pre, 30 months post), Borg scale, satisfaction, psychological demands.	Carrying tasks not full eliminated, manual hammering eliminated Reduction in RPE.	UECTD Incidence rate decreased 78%, 82% decrease in restricted or lost day rates.
Moore & Garg, (1996) Ex. 38–24; Moore & Garg, (1997) Ex. 26–21.	930 pork slaughtering plant employees.	Two departmental ergonomics teams used to analyze jobs and develop ergonomics interventions.	Quasi-experimental design, using post intervention comparisons of non-equivalent groups.	Exertions per minute, hand/wrist posture and strain index scores improved for leaf lard pulling job. Biomechanical stresses to the low-back, shoulders and guts hand eliminated on gut snatch job. Percent exertion per cycle, exertions per minute, and hand/wrist postures improved on rib pull job.	Not assessed.
Parenmark (1993)	Tool and Equipment manufacturing.	Engineering and organizational improvements in design of new factory: adjustable work heights, work technique training, job enlargement, work pace decrease 25%, work organization, flexible work hours, wage system, rehabilitation.	Pre-post design. Follow-up 18 months after production started in new factory, emg biofeedback to keep load below 15–20% MVC. Sick leave and turnover rate were outcome measures.	Not reported.	Sick leave decreased 5%. Turnover decreased 25%.
Rooney *et al.*(1992) Ex. 26–1056.	400 shoe and canvas luggage manufacturing employees.	Total quality management program, using an ergonomics team ‘‘to closely follow the proposed OSHA ergonomics guidelines’’.	Pre and post intervention job analysis.	373 job modifications, 85 of which achieved more than 25% reduction in force, repetition or postural stress.	Annual lost time incident rate reduced from 14.9 to 3.3 per 200,000 hours during four-year study period. Not analyzed for specific associations with job modifications.
Rosecrance & Cook (2000) Ex. 38–253.	455 Newspaper employees.	Continuous improvement process, using an ergonomics committee to manage a five step problem solving method.	Pre and post intervention questionnaires and non-structured interviews.	At least one intervention completed in eleven of twelve office and production areas, including engineering and administrative changes to problem jobs with static postures, repetitive tasks and non-adjustable workstations.	Not assessed at 4–6 months post intervention.

TABLE VI–11.—SUMMARY OF SCIENTIFIC STUDIES DESIGNED TO ASSESS THE EFFECTIVENESS OF ERGONOMIC INTERVENTIONS—Continued

Study	Population	Intervention	Analytic method	Exposure outcome	Health effects outcome
St. Vincent (1998) Ex. 500–71–64.	2 electrical product manufacturing plants.	Participatory ergonomics process: 7 jobs with 50 solutions implemented: improving material feed, repositioning of materials, change in work station dimensions, change in product jigs, tool changes, job enlargement, handling aids.	Pre-post design. Video analysis of posture, force, duration, frequency, impacts.	78% of solutions reduced risk factors (postural load, forces applied), 14% had no observable effect, 8% could not be evaluated.	Not reported.
Shi (1993) Ex. 26–1099.	County government workers.	One year Back injury prevention program: Individual health risk assessment at year 1 and year 2 in intervention group (fitness, job demands, satisfaction, demographics), training, ergonomic improvements (lifting devices, gait belts, improved seating, minimizing transport).	Pre-post randomized intervention groups (n=4, 77% participation) and control groups (2) with similar demographics. Measures: Satisfaction, HRA scores, symptoms prevalence, workers compensation rates.	Not reported	Nonsignificant frequent back pain prevalence decreased in intervention groups whereas overall prevalence significantly decreased. Significant increase in job satisfaction. Significant decrease in HRA risk status (not recorded for control groups). WC costs per claim increased in control groups but decreased in all intervention groups. Return on investment =179%. Participants believed ergonomic interventions contributed the most. No attempt to separate effects of ergonomics improvements from individual health promotion behavior in design or analysis.

Three individual studies are particularly persuasive (Melhorn *et al.*1999, Loisel *et al.*1997, Brisson *et al.* 1999). Melhorn *et al.* (1999) reported the results of a 5-step MSD prevention program based on OSHA and NIOSH ergonomics guidelines and implemented in a large aircraft manufacturing facility. This comprehensive program included education, risk factor analysis, job placement (including transitional (or ''restricted'') work), job modifications and medical management designed for employees based on individualized risk assessments. The authors followed a group of 3,152 newly hired sheet metal mechanics, using a prospective cohort design with pre-and post-intervention comparisons. Potential confounders considered included hours worked per employee, average number of employees and new hires, and rates in otherwise comparable plants without programs. The authors compared outcome data for several years pre- and post-program implementation. Although the recordable case incidence rate and the hours worked per employee increased moderately in the period studied, there was a substantial decrease in the lost time case incident rate, lost time severity rate, and workers' compensation costs per employee. Workers' compensation costs did not decrease in comparison facilities during the study. The authors reported a benefit to cost ratio of 16.5/1.0 for this program.

Brisson *et al.* (1999) conducted a longitudinal comparison of postural stressors and injuries in randomly assigned experimental (n=284) and control (n=343) groups of university employees keying five or more hours per week at a video display unit. The experimental group received ergonomic training in the identification of postural stressors and in making changes in equipment and work activities. Measurements were taken two weeks prior and six months post intervention. Symptoms questionnaires and standardized physical examinations were used to assess health effects, controlling for individual and lifestyle factors. Observational analysis was used to assess risk factor reductions. There were significantly greater decreases in the prevalence of three postural stressors (twisted neck, height of visual target, broken hand-wrist line) in the experimental group after the training than in the control group. There was also a greater decrease in the prevalence of musculoskeletal disorders as reported both in questionnaires and in physical examinations in the experimental group subjects under 40 years of age than in the control group. Symptom prevalence decreased from 29% to 13% in the experimental group for those less than 40 years of age. The prevalence of physical findings decreased from 18.8% to 2.9% for those under 40 in the experimental group compared to a decrease from 18.3 to 10.8% in the reference group. There were no significant differences between the experimental and control groups in hours of VDU use, psychosocial work factors, smoking, leisure time, or body mass index. The differences between the younger and older workers appeared to be related to the duration of symptoms with older workers having longer duration.

Loisel *et al.* (1997) used a population-based, randomized clinical trial design to evaluate 4 return-to work (RTW) approaches for workers with acute back problems who were absent from work for more than 4 weeks. These included occupational intervention (including ergonomics), clinical intervention, combined intervention or usual care. One hundred thirty employees from 40 different workplaces were followed for 1 year. Survival analysis was used to estimate return to work time. The occupational (ergonomics) intervention group and the combined intervention group returned to work 1.5 and 2.4 times faster, respectively, than the usual care group or the clinical intervention group.

OSHA finds that this additional body of scientific intervention studies, taken together with the other data presented in the preliminary-final risk assessments, provides strong evidence that ergonomics programs are effective in reducing MSD risks to workers. These studies have documented that reductions in exposure to biomechanical risk factors, as well as reductions in the rates of MSD cases and symptoms, follow implementation of ergonomic interventions. These findings are consistent with the epidemiological and biomechanical evidence presented in the Health Effects section that demonstrate the role of biomechanical risk factors in the development of MSDs.

OSHA also examined two recent reviews (Linton and Van Tulder, 2000, and Lincoln *et al.,* 2000) that concluded that the intervention literature provides little or no evidence of the effectiveness of ergonomics programs. OSHA finds these reviews unconvincing for the following reasons:

Linton and Van Tulder (2000, Attachment to Ex. 500–118) identified 900 articles about the prevention of musculoskeletal problems. They then restricted their evaluation to 20 studies of randomized controlled trial design and 8 studies of non-randomized trial design, each of which was designed to study ways of preventing long-term neck or back problems in subjects not seeking treatment; the methods used in these studies included back school training, exercise programs, etc. None of the studies involved workstation modifications, changes in controls or work practices, or administrative controls. Not surprisingly, the authors concluded that there is no evidence of good quality on the effectiveness of ergonomics interventions. OSHA gives this study little weight because the authors made an arbitrary decision that studies have no validity unless they are ''controlled trials'' (the authors do not define the term). The authors also exclude from consideration any studies of upper or lower extremity problems and any studies involving subjects who sought treatment. Their sweeping conclusion goes far beyond what is supportable, based on the very small group of 28 studies that meet their inclusion criteria.

Lincoln *et al.* 2000 [Ex. 500–118nn] assessed the intervention literature related to work-related carpal tunnel syndrome (CTS). Twenty-four studies met their inclusion criteria, which included having a comparison group; implementing engineering, administrative, personal or multiple component interventions; and describing outcome measures related to CTS or upper extremity MSDs. Although these authors found that multiple component programs were suggestive of positive effect, the authors concluded that lack of randomization and lack of control for confounding weakened the conclusions to be drawn from these studies. OSHA does not agree that this conclusion undermines the findings drawn from the many intervention studies reviewed by OSHA. As noted above, randomization of engineering controls in intervention studies is particularly problematic because very few employers are willing to permit investigators to dictate which employee groups receive different types of job interventions, or no intervention at all. Small sample sizes continue to limit research in this area as technology and markets change to more flexible niche market demands and as there is an increase in temporary workers limiting long-term follow-up of outcomes. This real-world phenomenon is not unique to the study of work-related musculoskeletal disorders. Frank *et al.*1996 [Ex. 38–207] pointed out that most of the study design factors that produce the most convincing evidence are outside the control of the researchers in occupational settings; such design factors include stable working populations and processes; randomization of intervention groups; and the need for long-term follow-up, which is made difficult during economic downturns, product or process changes, or during labor-management problems. In most cases, quasi-experimental designs, such as those reviewed by OSHA in Table VI–10, which use either concurrent comparison groups or historical control groups, present the best available evidence of the effectiveness of engineering or administrative controls in reducing occupational risks (Zwerling *et al.*, 1997, Ex. 500–71–65, Goldenhar & Shulte, 1994, Ex. 26–126). OSHA discusses the need for and use of randomized or controlled clinical trials in ergonomics research later in this section in response to comments that were made to the record.

In addition to the scientific studies, the record contains a large number of case reports documenting the experiences of employers and occupational health professionals who have implemented ergonomics programs. OSHA reviewed several of these in its preliminary risk assessment; however, since publication of the proposal, many additional case reports have become available. Generally, these reports, which are listed in Appendix VI–B, involve case studies of individual companies that have instituted programs that include some or all of the elements of the ergonomics program required by the standard; these reports describe the results of ergonomic interventions in a wide variety of industry sectors, including manufacturing establishments, service establishments, health care facilities, as well as in other workplaces where jobs routinely involve manual handling. Overall, OSHA identified over 300 case studies that quantified the reduction in MSD incidence following implementation of ergonomic programs and interventions; of these, 262 provided data on the reduction in MSD numbers or rates. From these studies, OSHA's measure of intervention effectiveness is based on 226 values for the reduction in total (*i.e.*, lost workday and non-lost workday) injuries and illnesses, and 81 values for lost workday injuries and illnesses. These case studies do not reflect a ''quasi-experimental'' study design because they do not use control groups and there is generally no evaluation of workplace exposures by an independent investigator; instead, a company's or establishment's MSD rate experience is evaluated before and after implementation of an ergonomics program or intervention. Thus, the outcome measure used in these studies reflects the measure that is probably most often used by employers who wish to evaluate whether their programs are effective. Documenting changes in MSD rates before and after implementation of an ergonomics program is, in fact, one of the methods listed in the final rule by which employers may evaluate the effectiveness of their ergonomics programs.

To characterize the experiences of employers and safety and health professionals in implementing these programs, OSHA determined the range, median, and mean reduction in MSD case rates for the overall data set, using the same approach as was used in the preliminary risk assessment. From each of these case studies, OSHA calculated the effectiveness of the standard (*e.g.*, employee involvement and training, implementation of engineering or work practice controls). These case studies of ergonomic interventions measure effectiveness as the percent reduction in either lost workday or total number of MSDs prior to and after implementation of the program. That is, effectiveness was calculated as the ratio

$$\left(N_B - N_A\right)/N_B$$

where N_B represents the number or incidence of MSD cases prior to implementation of the ergonomic intervention, and N_A represents the number or incidence after the intervention [1].

OSHA's estimate of the overall effectiveness of ergonomics programs is expressed as the median and mean reduction in MSD injury rates contained in this data set; Appendix VI–3 to this section tabulates OSHA's effectiveness measure for each of the case studies that provided quantitative data, and also shows the time interval over which the change in injury rate was measured. For all MSDs (*i.e.*, lost workday and non-lost workday MSDs), these case studies reported a median 67-percent reduction in injury rates (mean effectiveness was 64 percent). The median and mean reductions for lost workday MSDs only were somewhat higher, at 75 percent and 71 percent, respectively. Although the effectiveness of individual ergonomics programs varied widely among the establishments described in these case studies, most interventions (about 87 percent of the case studies) achieved at least a 30 percent reduction in MSD injury rates, 61 percent of the case studies reduced MSD rates by half or more, and several achieved the total elimination of lost workday MSDs (see Appendix VI–B).

E. OSHA's Response to Comments on the Program Effectiveness Evidence

Gibson, Dunn & Crutcher (Exs. 32–241–4, 500–197) raised several issues regarding OSHA's analysis in the proposed rule of the effectiveness of ergonomics programs. These issues were

- The lack of evidence that ergonomic interventions will reduce low back pain, as evidenced by a comprehensive literature evaluation conducted to develop the Agency for Health Care Policy and Research (AHCPR) medical guidelines for acute low back pain;
- The necessity of conducting randomized controlled trials to determine whether ergonomics programs will, in fact, be effective;
- OSHA's reliance on the epidemiological data in making inferences about the effectiveness of ergonomics programs; and
- Criticisms of individual case studies relied upon by OSHA to demonstrate program effectiveness.

In their post-hearing comments, from Gibson, Dunn & Crutcher (Ex. 500–118) stated that ''After conducting an exhaustive study, Dr. Bigos' panel, under the auspices of the AHCPR, 'failed to find evidentiary support for the use of ergonomic interventions to treat back pain injury complaints.' '' However, in the Executive Summary for the AHCPR low back pain guidelines, the purpose of the effort was clarified as follows: ''The Agency for Health Care Policy and Research (AHCPR) convened a 23-member, multidisciplinary, private-sector panel to develop a guideline for the *evaluation* and *treatment* of acute low back problems in adults.'' (Emphasis added)

Under the section entitled Scope and Organization, the following statement occurs: ''This Clinical Practice Guideline is intended to provide primary care clinicians with information and recommended strategies for the assessment and treatment of acute low back problems in adults.'' The word ''ergonomic'' appears four times. Twice, this term is used to describe back school programs included in the analysis. One citation simply points to a review of safe lifting. The final citation notes: ''Several ergonomic guidelines on lifting and materials-handling tasks are available to help the clinician provide ranges of activity alterations at work.'' Thus even the AHCPR panel felt it beneficial to employ ergonomic guidelines on lifting and materials handling in establishing safe levels of work activity for patients with acute low back pain. The section on prevention consists of a total of two paragraphs and 195 words, including a just three citations, two of which are opinion papers rather than research studies. Therefore, the published AHCPR low back pain guidelines do not, and do not purport to, have a focus on non-acute low back pain, work-related low back pain, ergonomics or prevention of low back pain. Citing the AHCPR guidlines as evidence that ergonomics interventions are not effective in reducing the risk of low back disorders is inconsistent with the cited purpose and scope of the document itself. Therefore, OSHA is not persuaded by this argument that the guidelines ''failed to find evidentiary support for the use of ergomonic intervention to treat back pain injury complaints;'' indeed, they would hardly have done so because they did not look for such evidence.

Regarding the second issue, Gibson, Dunn & Crutcher (Exs. 32–241–4, 500–197) asserted that randomized controlled trials (RCT) and controlled clinical trials (CCT) are the only study designs that can demonstrate whether ergonomics interventions are effective. They stated that:

> The fact that there is no RCT supporting the proposed standard is a major weakness in OSHA's position * * *. [W]ithout RCT, OSHA cannot show that the alleged risks at issue will be alleviated by particular solutions contained in its proposed rule. [Ex. 500–197, pp. I–104 to I–105]

They also quote the statements of two of their witnesses, Dr. Bigos and Dr. Fisher. Dr. Stanley Bigos, Orthopedic Surgeon and Professor in the University of Washington Department of Orthopaedics, called prospective RCTs:

[1] Note that, by this definition, the presence of background MSD cases (non-work-related cases) will decrease the apparent effectiveness of ergonomic interventions since the interventions would presumably not have any effect on the background rate of MSDs in the working population (*i.e.*, both N_B and N_A might contain background MSD cases).

* * * the gold standard for evaluating the efficacy of interventions in medicine. * * * This is a widely accepted standard across medicine, and across science. * * * The strength of the RCT is that both known and unknown risk factors are balanced across treatment groups, so that any differences in outcomes are more likely to be attributable to specific interventions (Ex. 500–197, pg. I–104).

Dr. Lloyd Fisher, Professor Emeritus in the Department of Biostatistics, University of Washington, likewise claimed that because there have been no RCTs on interventions in ergonomics, ''We have no evidence that these rules are going to work. They might work. They might be harmful.'' (Fisher Tr. 6740). A third witness, Dr. Shekelle, stated:

To my knowledge there is not a single well conducted randomized clinical trial of any intervention designed to modify any of the ergonomic factors proposed in the OSHA document that has proven to have a beneficial effect on disability due to back pain. (Ex. 500–197, pg. I–104).

Controlled clinical trials are used principally in medicine to test the efficacy of alternative treatments on patients. In a typical design, one group of patients that has been diagnosed with a specific disease or disorder is given the usual medical care and one or more other groups of patients with the same disease or disorder are given alternative treatments. The response of the test group(s) to the new treatment is compared with the response in the control group to determine whether the new treatment(s) were more or less effective than the standard for treatment. In a randomized trial design, the patients are randomly assigned to the various test or control groups; in a controlled, non-randomized clinical trial, assignment of patients to the various groups is not made using a purely randomized procedure. The randomized trial is considered overall to be the superior design since it has the greatest likelihood of controlling for both known and unknown confounders, increasing the ability to attribute any observed differences in treatment responses between the groups to the treatments themselves.

OSHA has carefully considered these comments that RCT studies in ergonomics are necessary to determine the effectiveness of interventions in reducing risk (and the related argument that such a high standard of scientific evidence is necessary before prevention procedures should be required). Although the Agency agrees with Dr. Bigos that RCT and CCT are the appropriate statistical designs for trials on the safety and efficacy of pharmaceuticals, or for a comparison of the effectiveness of different treatments for diseases and medical conditions, the study of interventions in ergonomics covers many more and different factors. Thus, any ergonomics RCT or CCT would require far more complex statistical designsand require many more subjects. Another major difference is that intervention studies, unlike typical medical or pharmaceutical efficacy studies, would start with healthy groups and then test for differences in subsequent risk or incidence of MSD. A pharmaceutical study equivalent, for example, would be a trial to test a drug that would prevent a specific cancer or chronic disease, not just treat it. Such medical RCT prevention trials would require a less complex statistical design than a good ergonomic intervention, *i.e.,* prevention, study; yet even are such a trial would be prohibitively expensive when the disease incidence is fairly low, (because many subjects would be required), and this expense would increase as the required follow-up time and effort increased.

As an example of the expense of an RCT ergonomic study, Dr. Frank, considering a simpler prospective design than required would be required for an ergonomic intervention study, in his testimony related his attempt to study physical loads on the back as an independent risk factor for workplace lower back pain, controlling for several individual characteristics of the worker:

And in a nutshell, we decided that the key thing was, and it is very expensive to do this, to actually measure the physical loads on the back. * * * It costs us about $2,000 U.S. dollars per subject. And we did well over 300 subjects to simply use a case-control design (emphasis added). * * * you cannot afford to do those measurements on the 5,000 workers, give or take a few thousand that you need to follow if you are going to use a cohort or prospective design to see who subsequently develops back pain (Tr. 1341).

In addition to the expense of RCT intervention studies, conducting such studies over a period of time sufficient to make valid conclusions, often means that unforeseen changes in conditions occur, invalidating the original study design. This is especially true when dealing which are often characterized by workplaces with changing conditions and workers who can self select on job or life style condition changes. For these reasons, and also because the number of industry sectors and variety of work conditions is so large, the results from the few carefully designed ergonomic RCTs that could be conducted over the next 5 to 10 years would be difficult to generalize to U.S. industry as a whole.

For all of these reasons, OSHA believes that sufficient RCT intervention studies could not be practically conducted within a reasonable time frame to justify delaying regulatory action. Therefore, OSHA disagrees with the arguments of the Coalition and its witnesses that OSHA should wait to issue its final rule until RCT studies can be conducted.

In estimating risk and risk reduction in this section, OSHA, as it has in all of its past rulemaking efforts, relies on the well-founded public health concept that, if risk factors can be identified that contribute to the etiology of disease, it is reasonable to act to reduce exposure to those risk factors to reduce the risk of disease. OSHA's logic and rationale in this rulemaking are similar to the position taken by Dr. John Frank, Professor, Public Health Sciences, University of Toronto (Ex. 500–64). Under the heading ''Standard Public Health Practice Regarding Hazard Control'', Dr. Frank poisted three conditions as the basis for deciding whether to implement ergonomic abatement policies:

- ''Is there 'reasonable cause' * * * to believe that exposure to the putative hazard truly does lead to measurable adverse health effects?'';
- ''Is there reasonable cause to believe that feasible hazard abatement/control intervention * * * *e.g.* ergonomic job modification/design * * * actually reduce exposure to the hazard?'' and
- ''Is there reasonable cause to believe that no significant harmful consequences of implementing such an intervention will occur * * *?'' (Ex. 500–64)

Regarding the first question, whether the evidence supports causal association between exposure to the hazard and workplace MSDs, OSHA has concluded in its Health Effects section (Section V) that there is substantial evidence that exposure to biomechanical risk factors at work—repetitive motion, forceful exertion such as heavy lifting, non-neutral body postures, contact stress, and segmental vibration—all contribute to the risk of MSDs. OSHA has followed the weight-of-evidence approach for evaluating the best available body of scientific evidence on ergonomics, especially the large amount of epidemiologic data, and finds that the evidence, as judged by the (Sir Austin Bradford) Hill criteria, used by the scientific community for over forty years, is convincing. Like Dr. Frank, OSHA especially notes the consistency in findings across epidemiologic studies and the consistency between the epidemiological studies and the accumulated scientific knowledge on biomechanics and tissue pathology that provide mechanistic explanations of the etiology of work-related MSDs. This body of evidence is also coherent in terms respect to temporality, *i.e.,* to the cause and effect timing and to the populations in which the effects are most frequent or severe. The Health Effects section (Section V) also contains sufficient evidence on exposure-response to further confirm these findings.

Dr. Laura Punnett, an epidemiologist and ergonomist, and member of the panel that reviewed the epidemiologic evidence on work-related MSD for the National Academy of Sciences, agrees with OSHA's findings:

> In summary, the epidemiologic evidence that links physical and ergonomic exposures at work with the risk of MSD is extensive and includes a sufficient number of methodologically strong studies to [implement] primary prevention activities. In the light of the experimental literature, the epidemiology is certainly most plausibly interpreted [as] showing a causal effect of occupational physical stressors on MSD among people with exposures on the job (Punnett, Tr. 874).

Having found that MSDs are causally related to multiple biomechanical risk factors, OSHA rejects the arguments of the commenters that OSHA should conduct RCTs in order to determine whether or which specific interventions will reduce MSD risk. OSHA believes that other types of approaches can be used; in particular, OSHA believes that the analogy between ergonomice interventions to address the multifactoral nature of ergonomic risk factors and interventions for the multiple risk factors associated with the development of coronary heart disease (CHD, *e.g.,* blood pressure, weight, smoking, and cholesterol) is appropriate. For CHD, risks and risk reductions were estimated for these factors long before there were any results from controlled prospective trials (Frank, Tr. 1340). OSHA notes the post-hearing comments of Anheuser-Busch Inc. and United Parcel Service Inc. comparison which included Dr. Michael Vender's and Dr. Arthur Barsky's objections to Dr. Frank's of CHD and back pain. Dr. Vender states that, unlike coronary heart disease, back pain is ''a subjective experience and can originate from many sources that are not readily identified or measurable, including muscle, ligament, joint and disc.'' (Ex. 500–118, Tab Kn pg. 21). OSHA finds Dr. Vender's argument irrelevant, however, since the relevant connection in Dr. Frank's analogy is that in the case of CHD the medical and public health communities implemented interventions to lower CHD risk factors that had been identified through study designs that were not RCT, rather than waiting to intervene until RCT studies had been conducted.

OSHA next considers the second question posed by Dr. Frank, whether there is reasonable cause to believe that feasible hazard abatement and control interventions (*e.g.,* ergonomic job modification/design) will actually reduce exposure to the hazard. As with its other rules, OSHA finds that, having identified specific biomechanical risk factors that contribute to the etiology of MSDs, procedures to reduce exposure to those factors will reduce risks. This is the underlying principle that has goverened all of OSHA's prior health rulemakings, and it is also the principle providing the foundation for public health interventions. Moreover, as the discussion earlier in this part of the Risk Assessment demonstrates, OSHA has accumulated substantial evidence, both scientific in nature and less formal, reflecting employers experiences with ergonomic programs, and showing that ergonomic interventions do reduce exposures to biomechanical risk factors and do reduce the prevalence and incidence of MSDs.

With respect to the types of studies needed to estimate risk and risk reduction, OSHA notes that potential risk reduction is estimated in many of the Agency's past rules by extrapolation of study results using mathematical dose-response models. None of these risk and risk reduction estimations relied on RCT. Several of these estimates were derived from modeling studies with retrospective cohort designs. In these studies, it was common in the course of the cohort's time frame that ''interventions'' occurred, in the industrial hygiene sense, to reduce exposures to the putative chemical agent. However, in these studies information about the exact interventions or exactly which cohort members these interventions affected is usually very limited, and the studies could hardly be considered ''controlled.'' Furthermore, all estimates for risk reduction required extrapolation beyond the range of observation, for which there were no ''interventions.'' This methodology is based on the logical rationale that if causes or risk factors for adverse health effects are established, a reduction in exposures to these factors will lead to a reduction in the adverse effects.

With regard to Dr. Frank's third question, whether there is reasonable cause to believe that no significant harmful consequences of implementing such an intervention will occur, OSHA has found no evidence in the record that implementation of ergonomic programs will harm employees; several of the scientific witnesses testifying on behalf of the UPS and others raised this possibility (Exs. 32–241–3–4), claiming that ergonomic interventions will result in deconditioning of the workforce and a resulting increase in the risk of MSDs. OSHA discussed this issue in detail in the Health Effects section (Section V of the preamble) and rejected this argument. In brief, OSHA finds that its final ergonomics program standard is consistent with current medical practice and guidelines, will not encourage an unhealthy level of inactivity in lieu of returning to a safe level of work following an injury, and is therefore unlikely to harm workers by discouraging conditioning.

Finally, several commenters presented arguments that it would be unethical to withhold interventions. The ethical arguments was summarized by Dr. Frank:

> There is also the moral impropriety of randomizing [for RCT studies] a set of communities or set of workplaces to not have a putative hazard abated (Ex. 500–64).

Dr. Punnett also testified that controlled trials are inappropriate in the context of protecting the public from exposures to hazardous agents. When asked whether controlled trials are the only scientifically rigorous method for determining causal relationships between exposure to risk factors and the risk of MSDs, she replied:

> You know, I really find that quite an extraordinary concept. * * * I could hardly imagine that OSHA would have ever been held to putting subjects in an exposure chamber and exposing them to coke emissions or benzene vapors or cotton dust to see whether they developed cancer or lung disease. And the whole idea that this would be the kind of evidence that would need to be provided in order for OSHA to take preventive action, truly it is astounding to me. And there are lots of examples. I mean, I showed international criteria documents, the European Union taking action on physical ergonomic exposures without ever a mention of such a thing as a randomized clinical trial in this area. [Tr. 1001–1002]

OSHA considers this ethical argument to be valid in that the Agency does not desire to delay hazard abatement in order to conduct an RCT, the result of which may or may not be generalized to worker populations overall. This is especially the case because the Agency already has a sound methodology for measuring the extent of current risk and the potential that reduction in risk associated with implementation of the standard.

Gibson, Dunn & Crutcher in their post hearing comments criticized OSHA for using epidemiology studies to assess the work-relatedness of MSDs and as a source of information and data to estimate the effectiveness of ergonomics programs (Ex. 500–118, pp. II–25 to II–36). Part of Gibson, Dunn & Crutcher's criticism relates to their claim that ''a statistical level of 'risk association' from an epidemiologic study cannot translate into a measure of effectiveness for OSHA's proposed program.'' (Ex. 500–118, p. II–27). They provided three reasons to support this claim. First, they claim, even assuming that OSHA's risk ratio estimates for the work-related MSDs are correct (which they do not concede), that by changing the job conditions:

> there will still be some level of force or repetition, some movement from completely neutral posture * * * that presumably could cause 'contact stress.' * * * In changing a job to address one 'risk factor,' moreover, an entirely different concern might be created. * * * Yet OSHA's approach would measure the effect as if it were the difference between the ''risk'' from the old job and *zero.* That assumption is simply wrong. (id. II–29).

Second, they claim that '' 'deconditioning' from a reduction in physical activity may play a very significant role in increasing the risk of MSDs. * * * An epidemiologic study that focuses solely on alleged 'risk factors' in the existing job, however, provides no mechanism for taking this into account, or any other change in the nature of a job as altered after an intervention.'' (Ex. 500–118, p. II–29). The third reason is that ''the 'risk ratios' yielded by epidemiologic studies control only for factors that each author was able to identify and analyze. * * * In the real world, * * * [with many other factors to be considered] the 'risk ratios' attributable to job factors, after fully accounting for all these other variables, would be far lower than those reflected in the epidemiologic evidence.'' (Ex. 500–118, p. II–30). OSHA notes that all of the ''real world'' complications pointed to by these commenters are also pertinent to RCF.

OSHA disagrees with all three of Gibson, Crutcher & Dunn's arguments that ergonomic risk factor epidemiology studies may not be used for risk reduction estimates. Gibson, Crutcher & Dunn argue that reducing one stress factor will either lead to increased risk due to exposure to another stress factor (reason one), or, contradictorily, lead to increased risk because the body is ''deconditioned'' and, therefore, more susceptible to injury (reason two). OSHA's approach for estimating the potential effectiveness of ergonomics programs, in both the Preliminary and Final Risk Assessments, is to estimate the proportion of disease occurring among workers exposed to risk factors that can actually be attributed to their exposure. This approach does not reflect a risk of ''zero,'' as Gibson, Dunn & Crutcher suggest. Instead, this approach explicitly recognizes that only *some* portion of the disease prevalence observed in a population of exposed workers will be affected by intervening to reduce the hazardous exposure. The risk ratios from epidemiological studies are precisely the kind of data that are used to estimate the attributable fraction of disease in an exposed population (*e.g.,* see Hagberg and Wegman Ex. 26–32). For example, if an epidemiological study reports that the rate of disease in an exposed population is twice as high as that seen in an unexposed population, (*e.g.,* an OR of 4), then the attributable fraction can be estimated to be 0.75, or 75 percent. This means that the rate of disease in the exposed population can be reduced by up to 75 percent in response to an intervention. The actual result achieved in an intervention may be less, depending on the effectiveness of the specific intervention employed. These commenters' third reason is that, because the epidemiology studies are limited and cannot control for enough risk factors, the risk ratio estimates from these studies overstate the risk due to the studied risk factor and cannot be generally applied to intervention risk reduction estimates. However, it is not always the case that study biases lead to an overestimate of the risk. Risk ratio estimates may overestimate or underestimate the true risk, depending on the study design, the interrelationship of the risk factors involved, and the comparison of the exposed and control groups. For example, errors in exposure assessment that arise because of the use of imprecise measures to characterize exposure (such as job title) leads to exposure misclassification, which usually results in an underestimate of risk, or even the observed absence of an association where one actually exists.

Gibson, Crutcher & Dunn further argue that, ''even if the epidemiologic evidence has some application, OSHA's review of it for benefit purposes was fatally flawed.'' (*id.,* pg. II–31). They offer several reasons for this opinion; their primary reason is that OSHA took an unweighted median or mean risk of ''every 'risk ratio' it could find in a NIOSH table, even in situations where the majority of study ratios—all but eight in one case—did not even satisfy measures of statistical significance.''(Ex. 500–118, p. II–33). In short, according to Gibson, Dunn & Crutcher, OSHA agglomerated studies of all qualities and all significance levels, studies measuring different risk factors, using different levels of exposure, and different types of control groups. ''The result, in the end, is a mathematically meaningless number whose content dependes primarily on happenstance.'' (Ex. 500–118, pg. II–33).

OSHA believes that there is a good rationale for applying this methodology to estimate median or mean risk ratios from the epidemiological data base by weighing each risk ratio equally (64 FR 65950–65951, see Table VI–9). OSHA believes that the use of epidemiological data and such unweighted median and mean risk ratio estimates, separately for each body part, using the epidemiological data is fair and appropriate, for several reasons. First, the epidemiological data, which is drawn largely from the 1997 NIOSH review (Ex. 26–1), is an unbiased screened review of the published literature, with the result that only higher quality studies are selected. Second, estimating risk ratios by body part agglomerates studies that reflect similar background rates; this should provide a more even distribution of risk ratio estimates than would be the case if all of the studies were grouped together.

Third, including all risk ratios by body part is reasonable, even though some studies estimated risks for more than one body part and may therefore be included in analyses of more than one body part. Often when more than one body part is included in the same study, the risk estimates are based on different subgroups of workers. In OSHA's final risk assessment any one study is included for each body part only once.

Finally, OSHA addresses the criticism of combining unweighted odds ratios from many different high-quality studies, even though NIOSH may have ranked studies according to their quality criteria. OSHA believes that, in this case, unweighted or equal-weighted means and unweighted medians are appropriate and fair. Most important, this methodology gives the same weight to high-quality studies that show no association as to those that do, instead of focusing on the highest risk estimate. OSHA believes this is fair because the large variety of study designs, work situations, and specific disorders addressed in these studies will be more representative of the varied nature of working conditions across the country. On the other hand, if OSHA were to weight risk ratios by some quality criteria, where the best designed studies are rated the highest, the resulting composite risk estimates would be more reflective of a small number of specific exposure conditions, and thus less representative of the broad mix of workplaces covered in the final rule. Consequently, given OSHA's objective to quantitatively characterize the work-related risk of MSDs and the potential effectiveness of ergonomic interventions, using the best available data, OSHA finds that its approach that makes use of all of the epidemiological data judged by the Agency to be of reasonable quality is preferable to relying only on a small subset of those data.

In both their pre- and post-hearing submissions (Exs. 32–241–4, 500–197), Gibson, Dunn & Crutcher raised several criticisms of some of the specific case studies relied on by OSHA in the preliminary risk assessment (these case studies were summarized in Appendix VI–B of the preamble to the proposed standard, 64 FR 65965–65975). In addressing each of these specific comments below, OSHA first identifies the case study or studies being addressed in the comment, quotes or summarizes the comment, and follows that with a response to the comment.

Group of 24 Case Studies From M. Oxenburgh, Increasing Productivity and Profit Through Health & Safety (Ex. 26–1041).

Comment: Methodology that Dr. Oxenburgh used is biased because he only obtained claims of reported success. ''Oxenburgh confirmed that he was looking to write a book * * * to demonstrate 'the effectiveness * * * from an injury reduction perspective' of ergonomic interventions [citing Tr. 2646]. Having 'made known what [he] was looking for,' [citing Tr. 2647] he obtained only reports of success.'' (Ex. 500–197, p II–10) ''* * * [T]reatise * * * unabashedly describes itself as an assemblage of ergonomic 'success stories' designed 'to make believers' out of management [citing p. 2 of Ex. 26–1041].'' (Ex. 32–241–4, p. 215).

OSHA's Response: The introduction to Dr. Oxenburgh's book was written by Dr. Stover Snook, who used the quoted phrases ''success stories'' and ''to make believers.'' Dr. Oxenburgh actually objected to terms such as ''making believers'' and ''success stories,'' because, as he stated at the hearings, he compiled ''a series of case studies which illustrate the concept of health and safety and productivity running together'' (Tr. 2643, ln. 11–13). Gibson, Dunn & Crutcher criticize Dr. Oxenburgh's publication as part of their argument that the case studies relied on by OSHA (which included some of Dr. Oxenburgh's case studies) are not scientific studies (see Ex. 32–241–4, pp. 10–214). However, in its preamble to the proposed rule, OSHA did not claim that the case studies it relied on represented ''scientific'' studies, but instead simply characterized them as sources of ''* * * data on the success of ergonomics programs and workplace interventions, * * * [which are in turn] supported by data from [other] scientific studies [*i.e.,* epidemiological studies and experimental laboratory studies in the record] indicating the potential for successful ergonomics programs'' (Ex. 28–1, p. IV–4). The 24 case studies from Dr. Oxenburgh's book that OSHA used as a source of effectiveness data provide precisely this kind of information, and OSHA does not find that the absence of a formal study design diminishes the utility of these data in describing the beneficial effects that ergonomic interventions have had on MSD rates in actual workplaces. In fact, real-world effectiveness studies, almost by definition, describe what happens in a particular workplace environment when interventions of the kind required by the standard are put into effect. OSHA did not in the proposal and does not in the final rule claim that these studies do more than report what employers have done and the results they have.

Comment: In his testimony, Dr. Oxenburgh stated that he relied as little as possible on written data (citing Tr. 2648), and preferred to accept what he was told on site by the people involved in implementing and working with the intervention (Exs. 500–197, p. II–11, 32–241–4, p. 215). Dr. Oxenburgh did not use a methodology that involved to verification of his claims (Ex. 500–197, pp. II–11). Oxenburgh was willing to accept employer accounts without independent verification (Ex. 32–241–4, p. 231). Dr. Oxenburgh's sources were health and safety professionals who had much to gain and nothing to lose by making exaggerated claims of benefits (Exs. 32–241–4, p. 231; 500–197, p. II–12).

OSHA's Response: To obtain information from establishments, Dr. Oxenburgh visited facilities to conduct personal interviews and perform inspections of the interventions firsthand (Tr. 2648). Although Dr. Oxenburgh did inspect some documents on the site visits, he sometimes obtained written documentation after the visit ''* * * by which time [plant contacts] would have looked up their information.'' (Tr. 2649) At the informal hearing, Dr. Oxenburgh testified that the information and data he received were reliable:

> I cannot see any reason why they should have told me any lies. They were very open with me. When I was going around a workplace, there were no restrictions placed on me to say, ''Oh, don't talk to the workers,'' or anything like that * * * I have no reason to believe that people were not telling me just the facts that were there. [Tr. 2714–2715]

The approach taken by Dr. Oxenburgh is often relied on by regulatory agencies (*e.g.,* OSHA and the EPA), academic researchers, and other investigators; it involves having individuals with professional expertise (in Dr. Oxenburgh's case, in ergonomics and productivity measurement) talk to involved individuals, take notes, inspect equipment and facilities, and evaluate what has been observed. For example, in conducting research to obtain data for the economic and technological feasibility analyses to support its standards, OSHA conducts many site visits to gather data on control technologies and work practices, worker exposures, costs of exposure controls, and economic data. In more than 20 years of experience, the Agency has never had reason to conclude that the information collected in this way is not reliable. In fact, site visits and onsite interviews generally provide much more detailed and accurate information than can be obtained in written form alone. OSHA believes that this is why Dr. Oxenburgh ''relied as little as possible on people's * * * written data'' (Tr. 2648): he understands that the answers to specific questions and to follow-up questions are far more revealing than the information in paper records. OSHA finds that the information and data collected by Dr. Oxenburgh and contained in his book are fair and accurate reports on the effectiveness of ergonomic interventions, and the Agency does not agree with Gibson, Dunn & Crutcher's insinuation that the data are unreliable. Further, Gibson, Dunn & Crutcher provide no evidence that the information in Dr. Oxenburgh's book is exaggerated or was misrepresented by safety and health professionals intent on promoting their reputations and careers. OSHA therefore rejects this argument as specious.

Comment: Each case study in Dr. Oxenburgh's book describes ''health, safety and productivity gains'' in broad generalities and rarely provides any quantitative statistics (Ex. 32–241–4, p. 215)

OSHA's Response: OSHA relied only on the 24 case studies from Dr. Oxenburgh's book that did in fact report quantitative changes in the number or rate of MSDs; these quantitative data are reflected in Appendix VI–B in both the preliminary and final risk assessments.

Comment: ''Oxenburgh holds a doctorate in biochemistry but, after 15 years in this field, saw a career opportunity during the early stages of the infamous Australian repetitive strain injury epidemic of the early 1980's and switched disciplines with no further academic training.'' (Ex. 32–241–4, p. 214) ''Primarily * * * Oxenburgh described his expertise as being based on various consulting activities he undertook after becoming ''interested in ergonomics'' and ''join[ing] the Ergonomics Society of Australia [citing Tr. 2700].'' (Ex. 500–197, p. II–12)

OSHA's Response: Gibson, Dunn, & Crutcher impugn Dr. Oxenburgh's professional experience and training but fail to acknowledge that Dr. Oxenburgh has in fact worked in the field of occupational health and safety since 1976 (Tr. 2700) and has practiced in the field of ergonomics for 20 years, since he joined the Ergonomics Society of Australia and became a committee member of the New South Wales division (Ex. 37–24, Tr. 2700). Dr. Oxenburgh also served for several years as a founder and co-ordinator of the Economics and Ergonomics specialist group of the International Ergonomics Association. Over the past 12 years, Dr. Oxenburgh has been an expert witness in more than 700 common law injury claims, in which capacity he has appeared about half the time on behalf of the employer and half the time in support of the plaintiff. Dr. Oxenburgh has also been the principal author on a number of research studies, including several seminal works on the quantifiable effects of early reporting and medical management (see, for example, Exs. 38–188, 26–1405, Winkle and Oxenburgh (1990) cited in Ex. 37–24, Oxenburgh (1997) cited in Ex. 37–24, Oxenburgh (1994) cited in Ex. 37–24). OSHA made Dr. Oxenburgh available to testify at the informal public hearing because of the importance of his work on ergonomics and productivity, and finds Gibson, Dunn, & Crutcher's characterization of Dr. Oxenburgh's qualifications both inaccurate and unjustified.

Comment: Regarding the robot case study contained in Dr. Oxenburgh's book, Dr. Oxenburgh admitted that this is a very unusual case (Tr. 2655) and that the workers are no longer performing that job at all (Tr. 2653). Consequently, there is no ''compelling justification for including it in a case study compilation to broadly represent ways in which employers purportedly can achieve '100%' effectiveness through ergonomic interventions.'' (Exs. 500–197, p. II–13, 32–241–4, p. 226).

OSHA's Response: Although the ''robot'' case study is an unusual case (because employers generally mechanize jobs but only rarely automate them), it is an example of an engineering approach that eliminated a job that had previously caused musculoskeletal injuries among an extraordinary high percentage of workers (60 to 80 percent of the workforce that performed these functions) (Tr. 2654). The engineering control (*i.e.,* the robot) was implemented after facility personnel determined that other options (*e.g.,* job rotation, increased rest breaks, and complete workstation redesign) would not prevent the injuries (Tr. 2654–2655, Ex. 26–1041, pp. 156–158). In his testimony, Mr. Caple also discussed situations in which robots are used in chocolate making and in the automotive industry (Tr. 2624–2625). However, both Dr. Oxenburgh's and Mr. Caple's testimony confirm that robotics are used rarely to control MSD risks. However, because of the unusual nature of the control approach in this case study (*i.e.,* robotics), OSHA has deleted it from the case study data set and is not relying on it in its effectiveness analysis.

Comment: ''It is surely no coincidence that 9 of the 24 Oxenburgh case studies invoked by OSHA cite General Motors as the source of information. At the time * * * General Motors was facing a major 5(a)(1) ergonomics citation, backed up by considerable pressure from its union on the subject of ergonomics * * * [GM] had every incentive to look for outlets to publicize that it was committed to ergonomics and was achieving results.'' (Ex. 32–241–4, p. 231)

OSHA's Response: Gibson, Dunn & Crutcher imply that the information and data taken from these 9 case studies are unreliable because GM was willing to fabricate or distort information to promote its ergonomics activities. OSHA does not believe that General Motors operates in this way, and the Agency notes that Gibson, Dunn & Crutcher provide no evidence of any kind to support their allegations that these 9 case studies are anything other than factual accounts of ergonomic interventions. Accordingly, OSHA is not persuaded by this comment.

Harley-Davidson Case Study (McGlothlin and Baron, Ex. 26–1080)

Comment: The case study documents a general upward trend in MSDs during the study period. ''The only way a decrease in injury rates could be claimed was to pick an aberrational year two to four years prior to program implementation and draw comparisons from that single statistical quirk'' (Exs. 500–197, p. II–14, 32–241–4, p. 227).

OSHA's Response: NIOSH initiated this Health Hazard Evaluation in 1990 and followed up in 1993; the purpose of the evaluation was to identify jobs associated with upper-extremity and back MSDs in the flywheel milling department, and to make recommendations to reduce MSDs in that department. The MSD incidence rates per 100 workers for the study period, as presented in Table 8 of the report (Ex. 26–1080), were 27.6 (1989), 11.5 (1990), 18.7 (1991), 13.4 (1992), and 12.5 (1993) (Ex. 26–1080). These data do not appear to support Gibson, Dunn & Crutcher's claim of a ''general upward trend in MSDs during the study period.'' Gibson, Dunn & Crutcher described the incidence rate of 27.6 for 1989 as a ''statistical quirk'' because it is substantially higher than the incidence rates for 1987 (11.8), 1988 (8.9), and 1990 (11.5) (Ex. 32–241–4, p. 227). The case study indicates, however, that this increased rate was associated with hiring a nurse between 1988 and 1989 who ''brought new vigilance to the reporting of musculoskeletal disorders'' (Ex. 26–1080, p. 12), suggesting that the lower rates reported for 1987 and 1988 reflect the underreporting, rather than low incidence, of MSDs. Further, the case study suggested that the MSD incidence for 1990, which was substantially lower than that for 1989 or 1991, may have decreased because of a sudden 20-percent increase in the department's workforce: new workers may have under-reported musculoskeletal problems, or it is possible that the disorders did not become symptomatic until the following year (Ex, 26–1080, pp. 12–13). For these reasons, OSHA does not agree that the MSD rate for 1989, which is taken as the base year for comparison with post-intervention years, is necessarily a statistical aberration, but rather that the lower MSD rates for the surrounding years may reflect underreporting of MSDs and abrupt increases in the workforce of the establishment. However, because of the concern raised about the representativeness of the injury rate for 1989, OSHA is basing its estimate of program effectiveness from this study on the injury rate for 1991, which represents the first year in which interventions were planned and implemented.

Telecommunications (Video Display Terminal (VDT) operator) Case Study (Tadano, Ex. 26–1337)

Comment: ''OSHA attributed significance to a '40.8' percent reduction in 'Total MSDs' allegedly achieved by an ergonomics program * * * [T]his reduction took place after a very substantial increase in MSD reports during the preceding period. The article suggests that this claimed reduction may have arisen from 'a certain operator hysteria about * * * catching [repetitive motion sickness], * * * possibly connected to sentiments, fueled by union activities, that 'management was * * * not doing enough * * * to curb this epidemic'' ' (citing Ex. 30–1337, p. 69). The reported reduction, therefore, might have nothing to do with the effectiveness of the ergonomics program and more to do with the statistical effect of ''regression to the mean'' (Ex. 500–197, pp. II–17–18).

OSHA's Response: This case study describes an ergonomic intervention implemented by a telecommunications establishment to address an increase in the rate of upper-extremity MSDs among VDT operators. There is nothing in the case study that supports Gibson, Dunn & Crutcher's contention that the observed decline in the number of upper extremity MSD cases and their associated medical costs was due to ''regression to the mean'' following an unusual increase in MSD rates, nor is there any suggestion by the author that ''operator hysteria'' was solely or even primarily responsible for the increase in the MSD rate prior to instituting the intervention. When reports of MSDs began to increase, the article stated that the ''* * * medical department staff was especially concerned, as they were aware that a similar department of a company branch in an adjacent state had been faced with [repetitive motion syndrome] in 'epidemic proportions'.'' (Ex. 26–1337, p. 69) The article also stated that ''* * * the job was considered stressful and monotonous by many operators,'' and that ''* * * [the] labor management relationship had previously been good.'' (Ex. 32–1337, p. 69) The author clearly attributed the decline in MSD cases following the ergonomic intervention to the intervention itself, and reported that ''* * * these results indicate the value of a positive approach to prevention of this occupational group [of disorders].'' (Ex. 26–1337, p. 70) Therefore, OSHA finds that it is appropriate to rely on this case study as part of its data set of ergonomic interventions.

Comment: ''Tadano also explains at length that CTDs 'have a multifactorial etiology' and that it is often not possible to attribute trends to any single intervention. She concludes:

> In the current study, so many factors were changed * * * that success or improvement cannot be attributed to any single factor. Also the data were limited, in that the sample size was small and the duration of time measured was limited.'' [Citing Ex. 26–1377, p. 70]

Yet, OSHA does exactly what Tadano warns it no[t] to do ''it attributes the entire * * * success or improvement * * * described in the article to the * * * single factor * * * of ergonomic interventions in the workplace'' (Ex. 32–241–4, p. 218–219).

OSHA's Response: Gibson, Dunn & Crutcher omitted an important part of the excerpt they quote from the Tadano study. The excerpt should read that ''* * * so many factors were changed (*i.e.,* worker methods, work-station design, addition of exercises, and mini-breaks) that success or improvement cannot be attributed to any single factor.'' The factors mentioned by Tadano all relate to the ergonomic interventions described in the study, and all would be considered appropriate engineering, administrative, and medical management interventions under the final rule. Thus, OSHA did not attribute the reduction in the MSD rate inappropriately, Gibson, Dunn & Crutcher imply; instead, OSHA, as well as the author of the study, attribute the post-intervention reduction in MSD rate to the collective effect of all of the components of the ergonomic intervention.

Leiyu Shi Study (Ex. 26–1099)

Comment: Although this study is a randomized study, there are serious flaws including small size and lack of sufficient study period to eliminate Hawthorne effect or other variables as potential explanations (Tr. 6823; Ex. 32–241–3–7, p.15). The author admits that ''* * * his analysis 'contains a number of limitations,' including the need for further examination and empirical testing to establish 'the reliability and validity' of the methodology he used and the very real possibility of 'a Hawthorne effect among the participating units' because employees knowing they are being studied react unusually and their reported behavior change may be more a result of their enthusiasm rather than that of an injury prevention program.'' [citing Ex. 26–1099, p. 210] (Ex. 32–241–4, p. 219).

OSHA's Response: The Leigu Shi study is a randomized trial of a back injury prevention program implemented among county employees; the program consisted of a combination of education, training, physical fitness activities, and ergonomic improvements. The author acknowledged that it was not possible rule out a Hawthorne effect bias in the results. However, although the author was aware of the potential for some confounding, he made several observations about the effectiveness of the back injury intervention program studied:

> The results of the study lend support to the widely held belief that health promotion in the workplace can significantly reduce employee health risks. * * * [T]he study offers suggestive evidence for the initial benefits of a back injury prevention program. Whether such interventions will continue to reap benefits in future years depends, to a large extent, on a *favorable work environment* and the maintenance and continuation of positive behavioral changes (emphasis added) (Ex. 26–1099, pp. 209–210).

I response to general comments in the record that the case studies OSHA used to indicate program effectiveness are seriously biased, OSHA does not dispute that these case studies, like all such reports and investigations, may reflect some bias; no study can eliminate all biases or potential confounders. However, the large number of case studies accumulated by the Agency makes it highly unlikely that any single unaccounted for confounder, such as the Hawthorne effect, could explain the consistent results reported in these studies as well as the effect OSHA postulates: that ergonomic interventions work.

Malcolm Pope Case Study of Telecommunications Workers (Ex. 26–1073)

Comment: As an example of an ''emphatic disclaimer'' OSHA's critics claim the authors of the technical articles made and OSHA ignored Pope explains in his article [which was used by OSHA in its effectiveness analysis] that ''there are other factors involved * * * [in low back pain] such as abnormal anatomy, the physical fitness of the individual, changes related to age and previous injury.'' (Ex. 32–241–4, p. 219, citing Ex. 26–1073, p. 450).

OSHA's Response: The Pope paper discusses the etiology of work-related low back pain and approaches for reducing back injury rates. Part of this report presents a case study of an ergonomic intervention in a telecommunications manufacturing facility. In discussing the etiology of low back pain, Pope stated, almost as an aside, that other factors may be involved; however, in discussing the etiology of low back pain, Pope emphasizes the importance of repeated biomechanical load on tissues. For example, the article stated that ''all connective and structural tissues [*i.e.,* even in those individuals who do not have abnormal anatomy, poor physical fitness, or advanced age] will fail if subjected to loads that are too high for too long a period of time without an opportunity for repair to occur'' (Ex. 26–1073, p. 450). In addition, he notes that ''[l]ow back pain has, in most cases [of over-exertion injuries reported], occurred due to a mechanical overload to one of the tissues of the back'' (*i.e.,* lifting to much, too far, too long, etc.) (Ex. 26–1073, p. 450). Dr. Pope concluded the section of his paper on etiology by stating that ''The key issue for those involved in the prevention of occupational injuries is to use epidemiologic information so that the relationships between load, repetition rate and exposure can be identified.'' (Ex. 26–1073, p. 450)

Dr. Pope then described the case study that exemplifies his approach (Ex. 26–1073, p. 453, abstract). The results of the case study showed that, within one year of implementing an ergonomics program that included engineering changes, the incidence rate of significant repetitive trauma disorders decreased from 1.1 cases per 100,000 working hours to 0.26 cases/100,000 working hours and lost work days decreased from 1,000 to 129 (*i.e.,* an almost eightfold decrease in lost work days). Dr. Pope concluded his paper as follows:

> An ergonomic approach, soundly based on biomechanical principles, will be effective in reducing such injuries if the correct management approach is taken. [Ex. 26–1073, p. 454]

Based on Dr. Pope's discussion of the etiology of low back pain and the conclusions that accompany the case study, OSHA does not agree that the reference to ''other factors'' cited by Gibson, Dunn & Crutcher represent an ''emphatic disclaimer'' of the case study's findings.

Westgaard and Aaras Study of a Telecommunications Manufacturer (Ex. 26–1026)

Comment: The authors note in this paper that ''musculo-skeletal illness may also develop as a result of other factors than work load, for instance as a complication because of other illnesses, due to general defects of the musculo-skeletal system, due to muscle spasms as a consequence of problems of a psychological nature, or to strenuous leisure time activities [;t]hus, one should not conclude that the work station is the major causal factor for any individual case of musculo-skeletal disorders' (Ex. 32–241–4, p.219, citing Ex. 26–1026, pp. 173–174). This statement represents another ''disclaimer'' that weakens the case study.

OSHA's Response: This study was a formal investigation of sick leave and medical records to evaluate the effectiveness of ergonomic improvements made in 1975 in a telecommunications parts manufacturing plant. Although the authors stated that ''* * * one should not conclude that the work station is the *major* causal factor for any *individual* case of [MSD]'' (emphasis added), there is no question that the investigators believed that reducing exposures to biomechanical load was responsible for reducing the sick leave associated with MSDs:

> There is no doubt that there has been an unusually high rate of musculoskeletal illness among the workers * * * in general. * * * It is also clear that the work situations have been strenuous, with the strain mainly affecting a limited number of muscles in the shoulder and neck region * * *. [I]t is very unlikely that those employed at the [work station] * * * have a sufficiently different life situation to other women of the same age to explain the group differences in sick leave due to musculo-skeletal disorders. The work load and, specifically, the strain on shoulder and neck muscles, *must* therefore be considered a *major* causal factor in the development of musculo-skeletal disorders among [the] workers [Emphasis added]. [Ex.26–1026, p. 174]

Thus, based on the specific conclusions reached by the authors of this study, OSHA finds that it appropriate to include this study among the data base of case studies that describe the effectiveness of ergonomics programs.

Meatpacking Case Study (Ex. 26–1043)

Comment: Group is too small to support statistically valid conclusions. Baseline of four reported injuries at meatpacking operation (Ex. 32–241–4, p. 220, see footnote 805).

OSHA's Response: This article describes the comprehensive ergonomics program implemented by a major meatpacking company. Although the program was implemented for ''all plant locations'' of the company, the article reports quantitative results only for the bacon department. Although the number of MSD cases is small, Gibson, Dunn & Crutcher fail to mention that the reduction experienced by the department was a decrease from four CTDs in *one month* to none in the *six months* following the implementation of the program (Ex. 26–1043, pp.138 & 140), a change that the author clearly attributed to the use of employee rotation in the department.

Ice Cream Manufacturer Case Study (Ex. 26–1100)

Comment: The group is too small to support statistically valid conclusions. Baseline of four compensation claims, not necessarily attributable to MSDs (Ex. 32–241–4, p. 220, see footnote 805).

OSHA's Response: This case study of a mid-sized ice cream manufacturer (230 workers in summer, 60 in winter) clearly identifies the four workers' compensation cases as involving ''soft tissue'' (Ex. 26–1100, p. 52). All of these claims occurred after the installation of six new workstations, whereas in the preceding seven years (before the workstations were installed) there had been no such claims. In addition to the decrease in the number of claims after the intervention, the implementation of ergonomic changes resulted in a decrease in absenteeism from ten to four percent, an increase in productivity of as much as 55 percent, and an overall increase in morale (Ex. 26–1100). Thus OSHA finds it appropriate to include this study in its database.

Cattle Feed Processing Case Study (Ex. 26–1046)

Comment: Group is too small to support statistically valid conclusions. Purportedly scientific article making claims based solely on the experience of two cattle feed processing employees without any attempt to explore the etiology of the reports (ex. 32–241–4, p. 220, see footnote 805).

OSHA's Response: This study describes a case in which a processing plant began producing experimental cattle feed in a manual operation. According to the article, the operation ''was apparently initiated without either pre-run trials or consideration of occupational health and safety issues'' (Ex. 26–1046, p. 27). The injuries sustained by the two employees were shown to have been a direct result of these specific workplace activities; between two and four weeks after beginning these specific workplace activities, both of the workers sustained irreversible back injuries. After engineering controls were implemented, there were no incidents of reported back pain during three subsequent trials of the redesigned process. The author reported that ''* * * [h]ad such countermeasures been implemented immediately, the irreversible injury would have been prevented'' (Ex. 26–1046, p. 28). Again, OHSA finds this study is appropriately included.

Hand Tool Operations Case Study (Ex. 26–1070)

Comment: Group is too small to support statistically valid conclusions: ''the data are inadequate for rigorous statistical evaluation'' (Ex. 32–241–4, p. 220, see footnote 805, citing Ex. 26–1070, p. 678).

OSHA's Response: This was a formal study of OSHA log and medical records at a telecommunications manufacturing facility during the implementation of a program to introduce redesigned hand tools and provide employee training on ergonomics; one of OSHA's expert witnesses, Dr. Thomas Armstrong, was a co-author of this study. The plant-wide incidence rate of OSHA reportable repetitive trauma disorders prior to the implementation of engineering and administrative ergonomic controls was 2.2 cases per 200,000 workhours and 1,000 lost workdays. In addition, incidence rates were as high as 4.6 percent in some areas of the facility and work restrictions were impeding the balance of production lines. Four departments accounted for 68 percent of all repetitive trauma injuries, and 48 percent of all repetitive trauma injuries occurred among assemblers (Ex. 26–1070, pp. 674, 676–677).

After the implementation of controls, repetitive trauma disorders decreased to 0.53 per 200,000 workhours and only 129 lost workdays. The authors stated that the contribution of the control program to the reduction in MSDs seen in the facility ''cannot be statistically tested using the available medical data,'' but emphasized that they believe the control program was ''an important factor in this reduction'' (Ex. 26–1070, p. 677) and stated that the program ''appears very promising'' (Ex. 26–1070, p. 678). Based on the authors own conclusions, OSHA finds that the reported reduction in MSDs in this plant are apprpriately attributed to the ergonomic interventions described.

Material Handling at Grocery (OSHA Site Visit) (Ex. 26–1176)

Comment: Group is too small to support statistically valid conclusions. ''From these data, it is not certain that costs associated with CTDs, the severity of CTDs (as represented by cost per claim), or the impact of CTDs on total medical claims have changed significantly for the long term'' (Ex. 32–241–4, p. 220, see footnote 805, citing Ex. 26–1176).

OSHA's Response: This case study resulted from an OSHA-sponsored site visit to a retail grocery establishment. Although the site visit report acknowledges its limitations in predicting long-term effects from the employer's newly implemented ergonomics program, it also stated the following:

> [I]t appears that [worker CTD compensation] claims have declined somewhat, but the program has not really been in place long enough to be able to verify a trend * * * It does look promising, however, particularly in terms of the number of CTD claims, which have fallen even while total employment has risen, and perhaps the average cost per claim.
>
> On a division-wide basis, members of the company CTD committee think that, as a result of the CTD strategy implementation, the numbers of CTD-related injuries and illnesses have decreased, the associated costs of claims (workers' compensation and medical) have decreased, employee complaints have been reduced, and employee morale has improved (Ex. 26–1176, pp. 12–13).

Thus, it is clear that this employer representative attributed the observed decline in MSDs directly to implementation of the program, and OSHA therefore finds it appropriate to include it in the data set being relied on by the Agency to evaluate the effectiveness of ergonomic interventions.

Garg and Owen Study of Ergonomic Interventions in a Nursing Home (Ex. 26–1093)

Comment: Group is too small to support statistically valid conclusions. ''[L]arge-scale studies in different nursing homes are necessary to confirm the * * * findings'' in the article (Ex. 32–241–4, p. 220, see footnote 805, citing Ex. 26–1093).

OSHA's Response: The study was conducted in two units of a nursing home which employed 57 nursing assistants. As a result of the controls implemented, the incidence rate for back injury decreased from 83 per 2,000,000 work-hours to 47 per 2,000,000 work-hours. The authors concluded that ''an appropriate ergonomic intervention program offers great promise in reducing physical stress and risk of low-back pain to nursing personnel.'' OSHA agrees that, as the authors stated in their article, the specific findings of this one study may not reflect the results achieved in other establishments that implement similar ergonomic measures. Garg and Owen explain that implementing such measures requires consideration of staffing levels, training, workload, and administrative support (Ex. 26–1093). However, the study by Garg and Owen is only one of several case studies used by OSHA to examine the effectiveness of ergonomics programs in nursing homes and other health care industry sectors (see Appendix VI–2 in this section of the preamble). These other studies also report reduced MSD rates that are attributed to ergonomic interventions, many of them similar to those investigated by Garg and Owen (*i.e.,* use of mechanical devices for patient lifting, modifying showers and toilets for easier access). Therefore, OSHA does not agree that it is inappropriate to include the Garg and Owen case study in the database, despite the authors' caution.

Couch, Summary of Six Case Studies (Ex. 26–1086)

Comment: The importance of non-work factors such as gender and age are mentioned as potential contributors. ''The above examples of the cost benefits of ergonomics are quite positive and indicate that ergonomics does seem to reap monetary rewards as well as improve worker well being. However, there are many factors that have not been accounted for or controlled in these reports; these factors, such as changes in the economy that reduce job turnover or changes in production technology and product lines that may eliminate high risk jobs or leave only the survivors in remaining jobs, may also contribute to the apparent payback. Because ergonomic case studies such as these are done 'in the field,' it is very difficult to hold these independent or external variables constant'' (Ex. 32–241–4, p. 220, see footnote 805, citing Ex. 26–1086).

OSHA's Response: OSHA recognizes that the case studies contained in Appendix VI–2 are, because of their real-world rather than laboratory nature, unable to control for a number of factors that could affect injury and illness outcomes; some of these factors are mentioned in the Couch article (Ex. 26–1086) and in Gibson, Dunn & Crutcher's comment. However, OSHA is not basing its finding that ergonomic interventions are effective on any single study or a few case studies. Instead, OSHA has identified more than 200 case studies from the record, all of which document reductions in MSD numbers or rates following implementation of ergonomic interventions. These case studies reflect a wide variety of industry sectors, workplace conditions, labor market conditions, and technologies. Nevertheless, despite the presence of confounding or modifying factors such as those mentioned in the Couch article, all of these studies attributed the observed reductions in MSD rates primarily to the ergonomic interventions described. Because such a large number of case studies yields such consistent results, OSHA finds it unlikely that the kinds of factors identified by Couch, rather than ergonomic interventions, were primarily responsible for the reductions in MSD rates reported in this large group of studies.

Automobile Cable Manufacturer (OSHA Site Visit) (Ex. 26–1181)

Comment: OSHA's estimate of the reduction in the number of MSDs pre- and post-intervention are based on numbers of illness cases, lost workday cases, and lost work days in 1991 and 1993. However, the statistics for 1993 represent only the first 9 months of the year. Further, the establishment reported an increase in the total number of injuries, which must include some MSDs, from 46 in 1991 to 65 in the first 9 months of 1993. OSHA cannot base its effectiveness estimate solely on the reduction in illness cases reported (Ex. 32–241–4, p. 222).

OSHA's Response: The site visit report clearly states in a footnote to the ''1993'' column which of the data ''covers [the] period from January to September 1993'' (Ex. 26–1181, p. 10). If the statistics for 1993 are extrapolated to cover a full year, based on the experience of the first 9 months, declines in lost workday cases and illnesses are still apparent: lost workday cases decline from 48 (1991) to 36 (1993) (a 25-percent reduction); the number of lost workdays decline from 1,287 (1991) to 367 (1993); and the number of illnesses decline from 47 (1991) to 23 (1993) (a 51-percent reduction). Although the report clearly indicates that the number of total injuries increased from 1991 to 1993, the report also states that ''[t]he facility believes that their ergonomics program has contributed to decreases in the following: number of overall illnesses, number and costs of worker's compensation claims, number of work days and lost workday cases, medical (*i.e.,* non-compensated disability) cost, and turnover'' (Ex. 26–1181, p. 9). These claims are supported by the data presented in the report. No reason was given for the increase in the total number of injuries from 1991 to 1993, nor was there any evidence in the report to suggest that the rise in total number of injuries was attributed to an increase in the number of MSDs. It is apparent, however, from the report that the employer would have been likely to classify some MSDs as injuries rather than illnesses. Therefore, OSHA has revised its analysis for the final rule to reflect that lost workday cases declined by 25 percent, and is not relying on the illness statistics presented in the report for its effectiveness analysis.

Luopajarvi et al.Study of a Food Packing Establishment (Exs. 26–1042, 26–1090)

Comment: OSHA attributed to an ergonomics program the elimination of hand MSDs from a pre-intervention level of 51 MSDs in 1976. ''The claim is false: the exhibit makes no reference to elimination of hand MSDs, and the underlying data tables confirm the existence of continuing injury reports. Moreover, ergonomic interventions were not even proposed at the plant until 1977, a year in which MSDs dropped to a level (20) more consistent with the lower rates existent prior to this year.'' (Ex. 32–241–4, p. 220).

OSHA's Response: Tables 3 and 4 of Ex. 26–1090 (p. 430) provide data on the numbers of hand MSDs from 1972 to 1984 in this food packaging facility. The incidence of hand MSDs increased steadily from 1972 to a high of 51 cases in 1976 and 20 in 1977; between 1979 and 1984, the table reported between 0 to 1 MSDs occurring annually, indicating that the problem had been virtually eliminated. OSHA has revised the entry for this case study in Appendix VI–2 to report the study's findings more precisely. With reference to the second part of Gibson, Dunn & Crutcher's comment, OSHA did not rely on the hand MSD statistics for its overall measure of program effectiveness, but on data presented in Table 5 of the article, which reported the number of MSDs of the neck and upper extremity in 1977 and 1981 and reflect an overall reduction in the number of MSD of 47 percent. Thus, OSHA is using 1977 as the baseline year, the year in which ergonomics interventions were being proposed.

Footwear Assembly Case Study (Ex. 26–1059)

Comment: OSHA attributes a 62-percent decline in MSDs over a 2-year period to an ergonomics training program. However, the article explains that ergonomic remedies were unsuccessful and the ergonomics training program ''* * * was actually a 'behavioral management' program designed to improve worker attitudes and morale'' (Ex. 32–241–4, p. 225). This case study is consistent with evidence that ''reports of pain are rooted in psychosocial factors rather than workplace 'hazards,' [and that] the attitude adjustment strategy apparently achieved what ergonomics could not.'' [Ex. 32–224–4, pp. 225–226]

OSHA's Response: This article describes a training program implemented at a footwear manufacturing facility that had 700 workers, 84 percent of whom were involved in repetitive tasks. The company experienced a rise in serious and lost-time upper-extremity MSDs throughout the early 1980's. The article does not claim, as the comment contends, that ''ergonomic remedies were unsuccessful.'' Instead, the article stated that several attempts were made to develop a ''safety program'' that was not further described (Ex. 26–1059, p. 52). If engineering solutions to address MSDs were implemented, they were not discussed in the article; instead, the article reported that ''because of the expense of workstation redesign in this very old facility, almost all human-factors engineering measures were also deemed to be impractical'' (Ex. 26–1059, p. 52). Therefore, no claim can be made as to the success of an ergonomic intervention based on engineering at this facility. The comment states that the program implemented was actually '' 'a behavioral management program' designed to improve worker attitudes and morale.'' Behavior management is defined in the article as ''simply the management of people in the work place in such a way that they interact with the environment in the most safe and efficient manner'' (Ex. 26–1059, pp. 51–52). The training ''attempted to educate employees on the causes and effects of [cumulative trauma disorders] * * * and the state workers' compensation system.'' (Ex. 26–1059, p. 53) The final rule requires employers to provide similar information to all employees on the causes and characteristics of MSDs. The program at the facility also encouraged employee participation, another important component of the final rule. OSHA does not agree with the comment that the case study demonstrates that psychosocial factors are more important that biomechanical factors; OSHA's review of the scientific evidence on the role of psychosocial factors is presented in the Health Effects section (Section V of the preamble), where the Agency finds that, although psychosocial factors play a role in the etiology of work-related MSDs, they do not outweigh the significance of exposure to biomechanical factors in the workplace and are independent of biomechanical efferts.

Sewing and Cutting Operations Case Study (Ex. 26–1060)

Comment: This is an article written by an OSHA area office employee about an inspection of a sewing facility. ''The article actually reports, however, that there was a steady decline in reported CTD rates beginning long before any ergonomic interventions: 26% in 1987, 18% in 1988, and 15% in 1989'' [citing Ex. 26–1060, p. 1]. The article does not identify exactly when ergonomic controls were implemented, but it does state that rates continued to decline to 14.6% in 1990 and 6.8% in 1991, but increased to 11% in 1992. The article also noted that ''there was an increase initially reported'' after ergonomics controls were implemented, which could only refer to the jump from 6.8% to 11%. Since no statistics are given for years after 1992, these data would suggest, if anything, that ergonomic controls *reversed* a previous trend of declining injury reports at this plant, prompting a 62% *increase* from 6.8% to 11%.'' (emphasis in original) [Ex. 32–241–4, p. 223]

OSHA's Response: This article reports on an OSHA inspection conducted at a sewing facility in October of 1989. Since the inspection, at least through 1992, the company had been working under an abatement plan that required the facility to develop and implement a comprehensive ergonomics program ''from the ground up'' (Ex. 26–1060, p. 3). In 1992, the year in which the MSD rate increased over that of 1991, the report stated that there were ''fewer incidents reported [overall],'' which suggests that employment in the plant had fallen since 1991 (there had previously been about 100 workers at this plant). There were also no surgeries reported in 1992, compared to 13 reported between 1987 and 1989 (Ex. 26–1060, p. 2). The report concludes that the ''lost workday injury rate has been effectively reduced,'' and noted that the number of employee complaints of MSD symptoms had fallen from 34 in 1991 to 14 in 1992 (Ex. 26–1060, p. 6). Therefore, OSHA does not agree with the analysis of this report by Gibson, Dunn & Crutcher, which suggests that the ergonomics program led to an increase in the rate of MSDs.

Poultry Processing Case Study (Ex. 26–1174)

Comment: ''OSHA claims that 'ergonomic solutions' at a poultry plant decreased recordable injuries and illnesses * * * from 10–14/100 workers (1988–89) to 7/100 workers (1991). * * * [T]he only two notable dips in recordable injury rate—which includes *all* injuries and not just MSDs—occurred between 1987 and 1988, when the rate declined from 14.0 to 10.5, and between 1989 and 1990, when there was a further drop from 10.5 to 7.5. The first occurrence took place before ergonomics began, and the second occurrence took place before the majority of the program was rolled out.'' (Ex. 32–241–4, p. 224) OSHA's attribution of the reduction in MSDs to the ergonomics program, when the reduction occurred prior to program implementation, and its use of total injury rates as if they were MSDs are ''blatant distortions of the truth.'' (Ex. 32–241–4, p. 224)

OSHA's Response: This case study is a site visit report of a poultry slaughtering and processing plant. The injury rate history of this plant was as follows: 14.0 in 1987, 10.5 in 1988, 10.5 in 1989, 7.5 in 1990, and 7.0 in 1991 (Ex. 26–1174, p. 17). The comment by Gibson, Dunn & Crutcher suggests that the reduction in injury rate that occurred in 1990 occurred prior to implemetation of most of the ergonomics program. However, the site visit report states clearly that $410,000 in capital cost was incurred for engineering controls in 1990, compared to $242,500 in 1991, indicating that most engineering improvements to address MSDs were made in 1990 (Ex. 26–1174, pp. 9–10). Therefore, OSHA does not agree that the 1990 injury rate reflects a time when most of the program had not yet been implemented. Further, the first drop in injury rate, which occurred in 1988, can be at least partly attributed to the large increase in employment in 1988 (from 950 workers in 1987 to 1,350 workers in 1988) (Ex. 26–1174, p. 17). Because of the change in employment in 1988, OSHA used the injury rates from both 1987 and 1988 as baseline years to calculate the percent reduction in injury rate pre- and post-implementation (*i.e.,* OSHA used an average baseline rate of 12 injuries per year). Additional evidence that the drop in injury rate in 1990–1991 can be attributed to the ergonomics program comes from other statistics provided by the facility that show drops in both worker absenteeism and turnover in 1990–1991 compared with earlier years; in contrast, there was no drop in absenteeism or turnover rates to accompany the drop in injury rate seen from 1987 to 1988 (Ex. 26–1174, p 17). Therefore, OSHA finds that the decline in injury rate seen in the 1990–1991 time period is most likely to have been the result of the ergonomic improvements made in 1990 and 1991 at this factility.

Packaging Sugar Cubes Case Study (Ex. 26–1041, Case 41)

Comment: OSHA attributes a 100-percent reduction of MSDs at a sugar cube packing operation, where the author of the study, Dr. Oxenburgh, stated that ''the *risk* of serious strain injuries to the hands and upper limbs has been virtually eliminated'' (citing Ex. 26–1041, p. 230, emphasis added). ''The statement only reflects the subjective judgement of Dr. Oxenburgh about 'risk'; he provides no actual data concerning actual injury experience after the change.'' (Ex. 32–241–4, p. 225) Further, the numbers are too small for statistical analysis, and ''Oxenburgh's unverified hunch about risk has no place in a statistical analysis.'' (Ex. 32–241–4, p. 225)

OSHA's Response: This case study describes a sugar cube packing operation in which 5 employees used a tool to pack cubes tightly into boxes. Because of the hand posture and pressure required to operate the tool, injuries to the hand and upper limbs occurred in about 1 out of 4 operators (*i.e.,* 25 percent of workers). After implementing an engineering and marketing solution that allowed the cubed sugar to be packed loosely into bags, productivity increased to the point where only 2 workers were required for the packing operation. The complete quote partially cited by Gibson, Dunn & Crutcher from the case study reads as follows: ''The risk of serious strain injuries to the hands and upper limbs has virtually been eliminated and has led to considerable savings in sickness absence and workers compensation.'' Although no statistics are presented, this is significant because it demonstrates a clear benefit from the change to the process. Rather than representing an ''unverifiable hunch,'' as Gibson, Dunn & Crutcher suggest, OSHA finds it logical to conclude from Dr. Oxenburgh's statement that no serious injuries occurred among the two remaining operators because the change eliminated the forceful repetitive motion (*i.e.,* pressing the sugar cubes together) responsible for the prior injuries.

Computer Manufacturer Case Study (Ex. 26–1068)

Comment: OSHA attributes a 41-percent reduction in upper-extremity disorders in 1994–1995 and a further 50-percent reduction in 1995–1996 to an ergonomics program. However, the program was implemented in 1991, after a year (1990) in which the company's upper-limb disorder rate was 0.5 per 100 workers. This rate increased to a high of 2.5 cases per 100 workers in 1994, after which they drop in 1995 and 1996. ''Thus, the reported declines in 1995 and 1996 brought the company down to approximately a 0.7 rate—a 40-percent *increase* over the experience it had during the last year before ergonomic interventions were introduced.'' (Ex. 32–241–4, p. 226, emphasis in original)

OSHA's Response: Although this computer manufacturer did implement an ergonomics program in the early 1990s, according to the case study, the program began ''with a reactive approach, addressing individuals.'' This isolated approach could be a reason why an immediate reduction in upper-limb disorders was not realized. In addition, ''[p]art of the increase in the number of CDT cases per year [from 1990 through 1994] can be attributed to the company's rapid growth, which more than doubled during that period.'' The trend was not reversed until the company, beginning in 1993, ''spent at least two days a week performing evaluations, held mandatory ergonomic training classes for high risk groups including technical publications, order[ed] administration and customer technical phone support, and created and distributed a 16-page ergonomics brochure.'' Additionally, with the growth in 1994 and 1995, the company purchased new furniture ''allowing employees a greater range of postures and flexibility.'' It was this expanded and comprehensive approach that led to the 41 percent drop in reportable upper-limb disorders from 1994 to 1995 and the further decrease of 50 percent in reportable CDT cases from 1995 to 1996 (Ex. 1068, pp. 7–8). Therefore, OSHA finds that the decline experienced in MSD rates beginning in 1995 is consistent with the company's implementation of ergonomic improvements that consisted of appropriate education and training of its workers, as well as workstation modifications.

Medical Device Manufacturer Case Study (Ex. 26–1183)

Comment: OSHA apparently attributes a 29-percent reduction in MSD rates from 1990 (2.1 cases per 100 workers) to 1992 (1.5 cases per 100 workers) to an ergonomics program (Ex. 32–241–4, p.228, footnote 857). However, ''the corporation did not begin to address ergonomic issues until 1991, did not formalize the program until 1993, and did not conduct training or implement the vast majority of its workplace modifications until 1992 or 1993. The result was a very substantial increase in 'ergonomics incidence rate' to 2.8 [per 100 workers] in the first three months of 1993 from * * * pre-intervention levels.'' (Ex. 32–241–4, p. 228)

OSHA's Response: This case study is a site visit report to a manufacturer that produced suction canisters used to collect blood during surgical procedures. The company began to address ergonomic issues in 1989 (a year in which their MSD rate was 5.2 cases per 100 workers), and first began to implement controls in 1991 (Ex. 26–1183, p. 2). OSHA used 1990, the first year prior to implementation of ergonomic controls, as the base year in its effectiveness analysis. The company continued to implement controls in 1992 and 1993. Since injury statistics were only available for the first 3 months of 1993, OSHA believed that a reliable injury rate could not be determined for that year. OSHA does not agree that the statistics available for the first quarter of 1993 show that the MSD rate was increasing because it reflected too short a period. Consequently, there are no data available in the report to permit an assessment of the effect of ergonomic interventions implemented in 1992 or 1993 at this facility. OSHA attributed the decline in MSD rates from 1990 to 1992 to the improvements made in 1991, based on the report's finding that ''[t]he facility believes that their ergonomics program has contributed to a general decrease in the plant's annual incidence rate for ergonomic-related injuries and illnesses.'' OSHA believes that this is an appropriate interpretation of this study. (Ex. 26–1183, p. 10)

Vehicle Seat Assembly Case Study (Ex. 26–1076)

Comment: This case study reported that the number of tendinitis and carpal tunnel syndrome cases had dropped 93 and 96 percent, respectively, but OSHA ignored information that the broader category of ''strains and sprains'' increased over the same period.

OSHA's Response: This is a case study of an automobile seat manufacturer that began experiencing problems with MSDs shortly after beginning full production. The ''slight'' increase in sprains and strains reported by the case study occurred during a time when the numbers of tendinitis and carpal tunnel syndrome cases dropped dramatically. According to the manufacturing manager, the increase in strains and sprains ''reflected the employees reporting the discomfort and pain [of MSDs] earlier.'' (Ex. 26–1076, p. 66) Because the increase in strain and sprain reports was described as ''slight'' by the manufacturing manager (Ex. 26–1076, p. 66), OSHA finds that the much larger decreases in the numbers of tendinitis and CTS cases fairly reflect the results achieved by the company's ergonomics program.

Aircraft Parts Manufacturer Case Study (Ex. 26–1179)

Comment: OSHA attributes a reduction of 96.2 percent in total MSD cases at an aircraft parts manufacturer ''based solely on data referring to specific diagnosis of CTS, ignoring information * * * clearly stating that the total 'number of reportable ergonomic injuries and illnesses [not just CTS] has actually increased since the ergonomics program began.' '' (Ex. 32–241–4, p. 232, citing Ex. 26–1179, p. 15, emphasis in original)

OSHA's Response: This case study is a report of a site visit conducted at an aircraft parts manufacturing facility. A formal ergonomics program was initiated in 1988, but did not have ''solid commitment from upper management and * * * [was] not readily accepted by the workforce.'' (Ex. 26–1179, p. 1) In 1991, the facility implemented a redesigned program following an OSHA citation, ''which [the program] proved to be very successful since it had the support of upper management and relied on hourly employees working together to identify and implement solutions to ergonomic problems.'' (Ex. 26–1179, p. 1) The facility reported that the *percentage of total recordable* injuries represented by ergonomics cases rose from 13.5 percent in 1991 to 20 percent in 1992 (*i.e.*, MSDs represented a larger proportion of all injuries and illnesses in 1992 than in 1991). This does not necessarily mean that the number or rate of MSDs increased during this period, as Gibson, Dunn & Crutcher claim. In fact, facility representatives stated that ''the actual number of [MSD] cases is at least holding steady.'' (Ex. 26–1179, p. 15) However, because the site visit report makes clear that there were MSD cases that occurred in the facility in addition to the CTS cases used by OSHA to calculate program effectivness, and because the report provides no statistics or other details on the number or rate of these cases, OSHA is no longer relying on this case study in its effectiveness analysis for the final rule.

Office Furniture Manufacturing Case Study (Ex. 26–1102)

Comment: OSHA claimed a 67-percent reduction in MSD rate, apparently from a ''passing reference to a claimed reduction in ''incidence rate'* * * (''incidence of what is not specificed)'' (Ex. 32–241–4, p. 232). However, the information presented in OSHA's Appendix VI–2 shows a reduction only from 21 per 100 workers in 1989 to 19 per 100 workers in 1991–1992, a change of only 9 percent ''that is of dubious statistical significance'' (Ex. 32–241–4, p. 232).

OSHA's Response: In OSHA's final analysis of the effectiveness of ergonomics programs, OSHA is basing its measure of effectiveness for this case study on the reported 9-percent decline in MSD rate. Regarding the comment on statistical significance, it was not OSHA's intent to limit its analysis of case studies only to those studies where the reported change in MSD rate could be shown to be statistically significant, primarily because most of the case studies lacked information to perform tests of statistical significance. OSHA believes it important to base its analysis on all of the experiences reported in the set of case studies, however large or small the result attributed to ergonomics interventions, and not to limit its analysis to the small group of case studies for which tests of significance could be performed.

Freight Truck Terminal Operations Case Study (Ex. 26–1177)

Comment: OSHA assumes a 46-percent decline based on a table that shows 13 MSDs occurred in 1989 and 7 in 1991, ''but it overlooks further information in adjacent sections of the report indicating that there have been ''no changes'' in overall * * * [MSD] incidence'' and that there has been no decrease in MSD-related disabilities (Ex. 32–241–4, p. 233)

OSHA's Response: This case study is a site visit report for a truck terminal operation. The site visit report was prepared in July, 1992 and contained a table that reported numbers of MSDs occurring in 1989 through 1991. OSHA's analysis of ergonomics intervention effectiveness was based on these numbers. Although the report stated that no decline in MSD-related disabilities had been seen, it also stated that the program had been recently implemented (in 1990) and ''its effectiveness may not yet be apparent'' (Ex. 26–1177). A follow-up telephone interview was conducted in January, 1994, at which time the employer indicated subjectively that there were no changes in MSD incidence. However, the employer also reported that the company ''had no hard data to back that up,'' and that no information was available to track changes in workers' compensation claims related to the ergonomics program (Ex. 26–1177, pp. 5–7 & 5–8). Therefore, it is clear that the employer had not been evaluating the performance of their program after 1991, and therefore no conclusions can be reached regarding the effectiveness of the program after 1991, the last year in which OSHA was able to obtain data on MSD injuries. OSHA finds that the quotes cited by Gibson, Dunn & Crutcher are not convincing in establishing that the ergonomics program was ineffective in the 1989–1991 period.

Materials Handling, Electrical Utility (Ex. 26–1085)

Comment: OSHA attributes 100-percent effectiveness to an ergonomics program based on a ''passing reference'' in the case study to eliminating 9 injuries just by getting in and out of vehicles. The article explains elsewhere that the total program is in its 'infancy stage' and the overall asserted effect so far has been to reduce lost-time injuries from more than one per 100 employees to 0.42, only part of which is allegedly attributable to ergonomics.'' (Ex. 32–241–4, pp. 233–234)

OSHA's Response: This case study is a published article describing the ergonomics program at a major utility company. OSHA based its measure of intervention effectiveness on the results of two specific interventions discussed in the article. These are not ''passing references'' but are examples of the earliest interventions implemented by the company:

> ''Downsizing water and ice kegs from 10 to five gallons and lowering their placement on trucks is one way we profited from ergonomic thinking right away * * * Since making the change, we've had no injuries associated with lifting water kegs' (Ex. 26–1085, p. 25).
>
> ''[t]hrough the use of ergonomics, 'we have reduced sprain injuries in several of our operations areas.['] For example, he says, 'we went from nine injuries last year from just getting in and out of trucks and vehicles, to zero this year'' (Ex. 26–1085, p. 25)

The article also makes clear that the ergonomics program is in its 'infancy stage' on the *corporate-wide* level, *i.e.*, that not all problems have been addressed at the time the article was published. For example, the article makes reference to workers who work at bill processing machines for extended periods of time and are at risk of developing carpal tunnel syndrome. Because the program had not yet been fully implemented, OSHA did not base its effectiveness measure on corporate-wide injury statistics (the company reported that total lost-time injuries declined from more than 1 per 100 workers to 0.42 per 100 workers) (Ex. 26–1085, p. 27), but instead based it on the proven effectiveness of the specific interventions discussed in the case study. After considering this comment and reviewing the case study, OSHA finds that this is still a reasonable approach and therefore has continued to include this study in its database.

Auto Air Conditioner Manufacturer Case Study (Ex. 26–1078)

Comment: ''[OSHA] * * * recites two examples from self-interested company officials claiming '50%' and '100%' reductions in 'total MSDs', while ignoring a lengthy description in the same article of scientifically documented experience at a different company showing that 'job improvements' cannot be expected to translate to any reduction in 'the number of back injury claims filed'.'' (Ex. 32–241–4, p. 234, citing Ex. 26–1078, p. 30)

OSHA's Response: The ''scientifically documented experience'' referred to by Gibson, Dunn & Crutcher is a short article by Dr. Stanley Bigos, University of Washington Department of Orthopaedics, describing his results from the Boeing study and the role of psychosocial factors in low back disability. OSHA discusses both the Boeing study and psychosocial factors at length in the Health Effects section (Section V) of this preamble.

UPS Case Study (Ex. 26–1084)

Comment: Steven Thompson, who co-authored a UPS report, ''does not believe that it would be legitimate to cite the article as evidence that ergonomic interventions pursuant to OSHA's proposal would have the effect that OSHA claims'' because, among other things, the article did not attempt to link the observed reduction in reported MSD cases to any particular cause or to account for the Hawthorne effect (Ex. 32–241–4, p. 217).

OSHA's Response: This case study is a published report of the results of an ergonomics program that provided adjustable sit-stand workstations to UPS employees using computer stations to perform a variety of tasks. Benchmark data collected prior to introducing the sit-stand workstations included production levels, absenteeism, survey results on operator comfort, and injury and illness rates. The study reported that injury and illness rates declined by more than 50 percent in the year after introducing the new workstations, and that there were no costs associated with the remaining injuries. In addition, the study reported an average reduction of 62 percent in symptoms of discomfort. There was no change in production level or absenteeism, which the authors believed may be partly explained by poor weather at the beginning [winter] of the follow-up year. In an attachment to Gibson, Dunn & Crutcher's submission, Mr. Thompson of the UPS, one of the co-authors of the study, stated that the article in question ''did not engage in the type of individual cause-and-effect analysis that would be necessary to link the observed reduction in reported MSD cases to the sit-stand workstation as opposed to other non-ergonomic factors.'' Mr. Thompson identifies several factors relating to the moving of the office location to a new building from an ''old crowded building.'' ''The new building had better lighting, ventilation, temperature control, windows, modular doors, and an overall open environment.'' According to Mr. Thompson's statement, the authors of the report ''did not account for the Hawthorne effect in light of these factors'' and other factors, some of which are often, in fact, considered engineering and administrative ergonomic changes.

In the original article, published as part of the *Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting,* the authors, Nerhood and Thompson, do discuss moving employees to a new building to provide a better working environment and providing adjustable sit-stand workstations for those employees ''with the heaviest risk of discomfort'' (Ex. 26–1084, p. 668). The authors also acknowledge the possibility of a Hawthorne effect being a ''contributing factor to any *production* changes'' (Ex. 26–1084, p. 671, emphasis added) because ''the study cycle was too short to hypothesize long term results [on production]'' (Ex. 26–1084, p. 668); however, nowhere in the article do the authors indicate that the Hawthorne effect was or could have been responsible for the observed drop in injury rate or operator discomfort. Despite the non-ergonomic changes in the work environment associated with the new building, the authors concluded that ''[t]he commitment from all groups involved was the key to the successful implementation of the *ergonomics* program and installation of the new adjustable sit-stand workstations'' (Ex. 26–1084, p. 671, emphasis added). Thus, in the original study, the authors attribute the reduction in operator discomfort and injury rate to the ergonomic intervention. Because of the strong conclusion made in the original study, OSHA finds it appropriate to retain this study in its data set.

In their post-hearing brief, Gibson, Dunn & Crutcher describe the testimony of several witnesses as examples of ergonomic interventions that failed (Ex. 500–197, pp. II–20 to II–23). The following summarizes these examples and OSHA's response to Gibson, Dunn & Crutcher's interpretation of the testimony.

Carl Zipfel, Seton Company

Comment: ''Carl Zipfel, Director of Environmental Compliance and Safety for Seton Company, a supplier of automotive interior leather, testified about his company's efforts to help employees who were stretching leather hides over a table and began to complain about shoulder problems. Seton Company tried every measure that OSHA could expect. * * * After all of these efforts no improvements were observed.'' (Ex. 500–197, p. II–20)

OSHA's Response: In his testimony at the informal hearing, Mr. Zipfel provided the following information, which explains why no improvements were observed:

• Under questioning, Mr. Zipfel agreed that Seton had no ergonomics program that would either meet the definition of an existing program under the grandfather clause or that would meet the requirements for an ergonomics program in the standard as proposed (Tr. 3051–3052).

• Although Seton has investigated incidents of MSD symptoms, the company has no one trained to do a job hazard analysis (Tr. 3066).

• Mr. Zipfel stated that Liberty Mutual and Penn State analyzed jobs and prepared reports for Seton regarding the leather stretching problem, but he never discussed what remedies were recommended in those reports or whether Seton tried to implement any of the suggested remedies (Tr. 3059).

There is no evidence in Mr. Zipfel's testimony that indicates that Seton had implemented engineering or administrative controls to address the problem at the leather stretching station; thus, OSHA does not agree that Seton ''tried every measure that OSHA could expect,'' and finds Mr. Zipfel's testimony unpersuasive evidence for the failure of ergonomics interventions.

Robert Willoughby, Boral Bricks

Comment: After implementing Boral's insurance company's suggestion of automating certain jobs in some of his facilities, the ''injury rates are not significantly better than [at] the plants that [have] more manual [jobs]'' (Ex. 500–197, pp. II–20 to II–21, citing Tr. 7776).

OSHA's Response: Mr. Willoughby stated that Boral's insurance company recommended the automation of two jobs: setting green, unfired brick on kiln cars and hand packaging the finished product (Tr. 7745–7746). It is clear from Mr. Willoughby's description that the automated equipment has contributed significantly to reduction in exposure to risk factors. For example, one automated piece of equipment that removes brick from the kiln required employees to stand on top of the cars and bend below knee level to lift bricks and place them into trays. Employees suggested and implemented an approach that prevented the need to bend below knee level but still required workers to lift bricks at waist height using an extended reach (Tr. 7787–7788). In this example, Mr. Willoughby commented without providing evidence, that ''what we have accomplished [from eliminating the deep bend] is going to be offset by the fact of extending the arms'' (Tr. 7788). On the other hand, Mr. Willoughby provided two examples of job fixes that he believed were worthwhile: one involved using pallets to package brick in smaller increments for easier handling, and the other used metal strapping bands and magnetic lifts to reduce the need for manual handling (Tr. 7790–7791). Regarding Boral's overall ergonomics program, Mr. Willoughby testified that he developed a written program a few years ago, but it has not been fully implemented; as part of their overall safety and health program, Boral currently provides information on MSDs, trains employees in recognizing potential hazards, and has safety and health committees at its facilities, some of which actively inspect the workplace and propose improvements (Tr. 7785–7786). Because of the continued exposure of employees to risk factors in jobs that had been automated, and Mr. Willoughby's testimony about the value of some of the interventions implemented by Boral, OSHA does not agree that the experience of Boral Bricks represents a failed ergonomics effort.

Mary Banks, Social Security Administration

Comment: Ms. Banks, a key operator who was diagnosed with DeQuervain's syndrome in 1998, testified that her symptoms have not improved at all and have gotten progressively worse in the year since she was provided with a new workstation. (Ex. 500–197, pp. II–21 citing Tr. 10664).

OSHA's Response: Ms. Banks described the new furniture as ''too little, too late'' for her (Tr. 10690). Her testimony indicated that her condition was quite severe:

> This impairment is devastating at times. I feel pain most of the time. It is difficult for me to pick up anything that weighs more than three pounds. It is hard to reach in back of me, to clap my hands even in church. It is difficult to open an envelope. I cannot pick up my grandbaby without fear of dropping him. (Tr. 10666–10667)

In addition, Ms. Banks was also diagnosed with tendinitis (Tr. 10667), and used only able to use her right hand to key at the time of the hearing (Tr. 10695). She concluded her testimony by stating that, if the ergonomics program had been in place, she would not have developed her condition (Tr. 10667). OSHA does not find that the lack of improvement in Ms. Banks serious upper-extremity disorder after she was issued a new workstation (details of which were not described during her testimony) constitutes adequate evidence that properly designed computer and VDT workstations are ineffective in reducing the risk of developing MSDs among healthy workers.

Dr. Charles Roadman for American Health Care Association

Comment: ''Dr. Roadman testified, however, that 'everything that we have tried has not decreased the incidents of [carpal tunnel syndrome]''' (Ex. 500–197, p. II–21 citing Tr. 4448).

OSHA's Response: Dr. Roadman was not discussing programs that members of the American Health Care Association (AHCA) had instituted to handle carpal tunnel syndrome, but was referring to an Air Force program he had instituted years before when he had been Surgeon General of the Air Force (Tr. at 4448). Although he felt that the interventions he had seen tried with computer users did not seem qualitatively to reduce the incidence of CTS, he also stated that ''that doesn't mean we should not keep trying to do that'' (Tr. 4448). In general, Dr. Roadman has positive things to say about ergonomic programs. He discusses favorably programs that the AHCA created with the assistance of OSHA (Tr. 4355–6). He also stated that ergonomic programs ''can be very positive if all the factors are in place and you have good cooperation * * * between labor and management and the assessment process. Yes, they can be very successful'' (Tr. 4436).

From the examples above, OSHA is not convinced that the testimony cited by Gibson, Dunn & Crutcher demonstrate that ergonomic interventions are ineffective, as a general matter.

BILLING CODE 4510–26–P

Appendix VI-A. BLS Injury Categories Likely To Include Employer-Reported Musculoskeletal Disorders

BLS Code	Nature of Injury	Description
00	Traumatic injuries and disorders, unspecified	This major group classifies traumatic injuries and disorders when the only information available describes the incident as traumatic. For example, employee was hurt in car accident.
01	Traumatic injuries to bones, nerves, spinal cord	This major group classifies traumatic injuries to the bones, nerves, or spinal cord which include breaking and dislocating bones and cartilage and traumatic injury to the brain, spinal cord, and nerves.
011	Dislocations	subluxations; slipped, ruptured, or herniated disc; partial displacement; and fractured or broken cartilage
012	Fractures	closed fractures for which no open wound exists; open fractures for which there is an accompanying open wound; comminuted, compound, depressed, elevated, fissured, greenstick, impacted, linear, march, simple, and spiral fracture; and slipped epiphysis
013	Traumatic injuries to spinal cord	severed spinal cord, nonfatal severed spinal cord resulting from a gunshot wound, traumatic transient paralysis, anterior cord syndrome, lesion of spinal cord, and central cord syndrome
014	Traumatic injuries to nerves, except the spinal cord	This nature group classifies traumatic injuries to nerves other than the spinal cord. Cranial nerves, peripheral nerve of the shoulder or pelvic girdle, and nerves of the limb are possible locations for injuries in this nature group. Diseases or disorders of the nervous system that occur over time as a result of repetitive activity, such as carpal tunnel syndrome, are classified in major group 12. Includes division of nerve, lesion in continuity, traumatic neuroma.
018	Multiple traumatic injuries to bones, nerves, spinal cord	This nature group classifies multiple injuries and disorders of equal severity within Traumatic injuries to bones, nerves, spinal cord, major group 01.

Appendix VI-A. BLS Injury Categories Likely to Include Employer-Reported Musculoskeletal Disorders (continued)

BLS Code	Nature of Injury	Description
019	Traumatic injuries to bones, nerves, spinal cord, n.e.c.	
020	Traumatic injuries to muscles, tendons, ligaments, joints, etc., unspecified	Traumatic injuries that affect the muscles, tendons, ligaments or joints; exact nature of disorder not specified in employer's report.
021**	Sprains, strains, tears	This nature group classifies cases of sprains and strains of muscles, joints tendons, and ligaments. Diseases or disorders affecting the musculoskeletal system, including tendonitis and bursitis, which generally occur over time as a result of repetitive activity should be coded in Musculoskeletal system and connective tissue diseases and disorders, major group 17. Includes avulsion, hemarthrosis,, rupture, strain, sprain, or tear of joint capsule, ligament, muscle, or tendon. Excludes hernia (153), lacerations of tendons in open wounds(034), torn cartilage (011).
029	Injuries to muscles, tendons, ligaments, joints, etc., n.e.c.	This nature group classifies injuries to muscles, tendons, ligaments, etc. that are not classified elsewhere in this major group.
0972** 0973** 0978 0979	Back pain, hurt back Soreness, pain, hurt, except the back Multiple nonspecified injuries and disorders Nonspecified injuries and disorders, n.e.c.	Subcategories under nature group 097, Nonspecified injuries and disorders, which includes traumatic injuries and disorders where some description of the manifestation of the trauma is provided and generally where the part of body has been identified. Subcategory 0972 includes hurt back, backache, low back pain.
099	Other traumatic injuries and disorders, n.e.c.	
1240 1241** 1249	Disorders of the peripheral nervous system, unspecified Carpal tunnel syndrome Other disorders of the peripheral nervous system, n.e.c.	Subcategories under nature group 124, Disorders of the peripheral nervous system, which includes the nerves and ganglia located outside the brain and spinal cord. Subcategory 1249 includes Bell's palsy, tarsal tunnel syndrome, other mononeuritis of the extremities, nontraumatic lesion of the median, ulnar and radial nerves, muscular dystrophies.
1371	Raynaud's syndrome or phenomenon	Subcategory under nature group 137, Diseases of arteries, arterioles, capillaries.

Appendix VI-A. BLS Injury Categories Likely to Include Employer-Reported Musculoskeletal Disorders (continued)

BLS Code	Nature of Injury	Description
153**	Hernia	This nature group classifies hernias of the abdominal cavity. Includes: femoral (1539), esophageal (1539), hiatal (1532), inguinal (1531), paraesophageal (1539) scrotal (1531), umbilical (1539), and ventral (1533) hernias. Excludes: herniated disc (011), herniated brain (1231), and strangulations (091).
17**	Musculoskeletal system and connective tissue diseases and disorders.	This major group classifies diseases of the musculoskeletal system and connective tissue.
170	Musculoskeletal system and connective tissue diseases and disorders, unspecified	
171	Arthropathies and related disorders (arthritis)	This nature group classifies joint diseases and related disorders with or without association with infections. Includes: ankylosis of the joint, arthritis, arthropathy, and polyarthritis. Excludes: disorders of the spine (172), gouty arthropathy (1919), rheumatic fever with heart involvement(131).
172	Dorsopathies	This nature group classifies conditions affecting the back and spine. Includes: spondylitis and spondylosis of the spine (1729); intevertebral disc disorders, except dislocation (1723); sciatica (1721); lumbago (1722); and other nontraumatic backaches (1729). Excludes: dislocated disc (011), curvature of the spine (1741), fractured spine (012), herniated disc (011), ruptured disc (011), traumatic sprains and strains involving the back (021), and other traumatic injuries to muscles, tendons, ligaments, or joints of the back (02), and traumatic back pain or backache (0972).
173	Rheumatism, except the back	This nature group classifies disorders marked by inflammation, degeneration, or metabolic derangement of the connective tissue structure of the body, especially the joints and related structures of muscles, bursae, tendons and fibrous tissue. Generally, these codes should be used when the condition occurred over time as a result of repetitive activity. Includes: rotator cuff syndrome (1739), rupture of synovium (1739), and trigger finger (1739). Excludes: rheumatism affecting the back is included in code (172), traumatic injuries and disorders affecting the muscles,

Appendix VI-A. BLS Injury Categories Likely to Include Employer-Reported Musculoskeletal Disorders (continued)

BLS Code	Nature of Injury	Description
		tendons, ligaments and joints (02).
174	Osteopathies, chondropathies, acquired deformities	This group is comprised of diseases of bones, diseases of cartilage, and acquired musculoskeletal deformities. Includes: osteomyelitis, periostitis and other infections involving bone; and acquired curvature of the spine.
179	Musculoskeletal system and connective tissue diseases and disorders, n.e.c.	This nature group classifies musculoskeletal system and connective tissue diseases and disorders that are not classified elsewhere.
4120	Symptoms involving nervous and musculoskeletal systems, unspecified	Subcategories under nature group 412, Symptoms involving nervous and musculoskeletal systems, which includes symptoms specific to either the nervous or musculoskeletal systems. Subcategory 4129 includes abnormality of gait, lack of coordination, tetany, and meningismus.
4128	Multiple symptoms involving nervous and musculoskeletal systems	
4129	Symptoms involving nervous and musculoskeletal systems, n.e.c.	
414	Symptoms involving head and neck	This nature group classifies symptoms which are specific to either the head or neck. Includes: throat pain (4149), aphasia (4149), and epistaxis/nosebleed (4149).

** Categories included in OSHA's preliminary risk assessment.

Source: Occupational Injury and Illness Classification Manual, Bureau of Labor Statistics, December 1992 (Ex. 26-1272)

Appendix VI-A. BLS Injury Categories Likely To Include Employer-Reported Musculoskeletal Disorders

BLS Code	Nature of Injury	Description
00	Traumatic injuries and disorders, unspecified	This major group classifies traumatic injuries and disorders when the only information available describes the incident as traumatic. For example, employee was hurt in car accident.
01	Traumatic injuries to bones, nerves, spinal cord	This major group classifies traumatic injuries to the bones, nerves, or spinal cord which include breaking and dislocating bones and cartilage and traumatic injury to the brain, spinal cord, and nerves.
011	Dislocations	subluxations; slipped, ruptured, or herniated disc; partial displacement; and fractured or broken cartilage
012	Fractures	closed fractures for which no open wound exists; open fractures for which there is an accompanying open wound; comminuted, compound, depressed, elevated, fissured, greenstick, impacted, linear, march, simple, and spiral fracture; and slipped epiphysis
013	Traumatic injuries to spinal cord	severed spinal cord, nonfatal severed spinal cord resulting from a gunshot wound, traumatic transient paralysis, anterior cord syndrome, lesion of spinal cord, and central cord syndrome
014	Traumatic injuries to nerves, except the spinal cord	This nature group classifies traumatic injuries to nerves other than the spinal cord. Cranial nerves, peripheral nerve of the shoulder or pelvic girdle, and nerves of the limb are possible locations for injuries in this nature group. Diseases or disorders of the nervous system that occur over time as a result of repetitive activity, such as carpal tunnel syndrome, are classified in major group 12. Includes division of nerve, lesion in continuity, traumatic neuroma.
018	Multiple traumatic injuries to bones, nerves, spinal cord	This nature group classifies multiple injuries and disorders of equal severity within Traumatic injuries to bones, nerves, spinal cord, major group 01.

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
1	Food Packing	20	Implemented full program in 1976 on packing line, including job task analysis, employee involvement in identifying problems and solutions, worker training, and medical management. Job analysis resulted in 56 proposals for changes in equipment and work environment, half of which were implemented in six months.	Not Reported	In 1976, prior to implementing the program, there were 51 hand MSDs identified among 200 packing workers. Hand MSDs were eliminated by 1980, four years after program implementation. Other upper extremity illnesses declined by about 47% in this same time period.	Luopajarvi et al. (1982) (Ex. 26-1042); Luopajarvi et al. (Undated) (Ex. 26-1090)
308	Meat Industry	201	Fleshing machine was modified so workers no longer have to lift and rotate beef to remove the hide.	Lost days were reduced from 126 to 0, saving $9,765 in additional labor and $35,700 in medical and workers' compensation.	CTD incidence rates fell from 7 to 2 cases (71%) and worker comfort increased 30%.	(Ex. 500-114)
197	Meatpacking	2011	The company's ergonomics program addressed small and large problems. A recent big project involved a reconfiguration of the front half of the loin-boning line. This involved changing the direction of the loins coming down the line, from cross ways to length ways. This reduced reach to almost zero for those persons on that end of the line, which had several very ergonomically challenging jobs due to work loads at extended reach creating severe ulnar deviation problems. The company uses safety and ergonomics committees as well as a business improvement team that has been trained in ergonomics.	In 1996,the first year of their re-emphasized ergonomics program they reduced their lost work-day injuries by 81 (compared to 1995), and saved $70,000 in worker's compensation costs. Lost work day injury incidence rates have continued to decline from 1996 to 1998 (33.1 to 28.7).	Not Reported	OSHA case files (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
198	Meatpacking	2011	This company has developed and implemented a comprehensive ergonomics program as one key ingredient of an overall safety and health program. Employee input is also an important aspect in the company's safety and health program. Ergonomics training was provided to managers, supervisors, lead people, trainers, and production workers. Ergonomic job analyses were completed resulting in the identification of 20 jobs having risk factors associated with upper extremity musculoskeletal disorders. Risk factors were measured and abatement actions were undertaken to reduce these risk factors.	In the first year of their cooperative effort, they reduced their days away from work by 71%, their lost work-day injuries by 19%. This record was achieved despite a 12% increase in hours worked	In the first year of their cooperative effort, they reduced their overall injuries by 40%, sprains and strains by 52%, lacerations by 30%, and cumulative disorders by 32%. This record was achieved despite a 12% increase in hours worked.	OSHA case files (Ex: 502-22)
185	Meat Processing	2011	The company set up an ergonomics committee including management, engineering and production personnel to manage the ergonomics program. An ergonomics checklist was developed for all workstations. The company identified jobs with multiple risk factors and eliminated the risks. The company found ninety-five percent of the work site improvements easy to do. A few, such as installation of an automated deboning machine, required a greater financial investment.	Not Reported	Ergonomic and safety improvements reduced the incidence of OSHA recordable injuries by 17% in one year (1991 to 1992). Medical costs declined 15%.	Putting it on the table," *The National Provisioner*,(October 1992). (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
128	Meatpacking	2011	In 1984, the company developed its ergonomics program which includes: *Employee technique *Equipment and workstation design *Administrative controls, such as job rotation *Job analysis. They videotape each worker performing his/her job and then play the tape in slow motion to pinpoint risk factors. These tapes are also used to compile "physical demands assessments" (PDAs). The PDAs essentially quantify a job's requirements, i.e., how much lifting, stretching and reaching will be necessary to perform the tasks involved. PDSs are primarily used to determine whether an injured worker can return to work. *Training. The training, known as the Industrial Athlete Program, includes a two-hour seminar, videotapes and workbook. *Employee suggestions.	Not Reported	CTDs have decreased by 60%, even though the work force has increased by 27%.	James M. Burcke, "Tackling Cumulative Trauma Disorders," *Business Insurance,* (4/18/94). (Ex: 502-22)
5	Meat Preparation	2011	Introduction of engineering controls: redesigned workstation by sloping the work surface toward the meatcutter; introduced rotary cutter and single hooks.	Not Reported	80% reduction in musculoskeletal injuries in the first year.	Oxenburgh (1994) (Ex. 26-1041), Case 45

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
230	Meat Processing	2011	To reduce work-related musculoskeletal disorders in its meat process facility, this company introduced ergonomic hand tools and power tools and mechanized lifting equipment. The company also reviewed and modified production rates and staffing levels.	Not Reported	This company reduced work-related musculoskeletal disorder injury rates from 13.64 per 100 employees in 1989 to 4.37 per 100 employees in 1993.	Corporate settlement agreement report to OSHA (Ex: 502-22)
329	Meatpacking	2011	Implemented a comprehensive ergonomics program. Consist of Labor-management committee, ergonomic monitors, jobs are videotaped for study, workstations are improved where possible, administrative controls were not possible, training of workers' and supervisors.	Worker compensation costs declined by more than 50% between 1988 and 1993.	Diagnosed RSI cases have been reduced by 50%. RSI related surgeries have decreased by 40%.	(Ex: 32-339-1-1)
2	Meatpacker	2011	Training efforts included awareness training of corporate and plant managers and technical training of safety and medical personnel. Ergonomic task forces were established at individual plants to identify problem jobs and implement exposure controls. Controls included use of anti-fatigue mats and manual handling assists such as conveyors and trucks. Job rotation and cross-training of rotated workers were also employed.	Not Reported	Cumulative trauma injuries reduced from four in one month to none reported during a 6-month period.	McCasland (1992) (Ex. 26-1043)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
220	Meatpacking	2011	In compliance with their settlement agreement, this company established a comprehensive ergonomics program with elements that included: training, recordkeeping, job analyses, and medical management. NIOSH and OSHA made several site visits to assist with program implementation.	Not Reported	After establishing a comprehensive ergonomic program, ergonomic injuries declined by more than 85 percent. These declined as follows: 1988–364; 1990–189; 1993–89.	OSHA case file documentation (Ex: 502-22)
4	Meatpacker	2011	Implementation of an ergonomics program, including engineering controls, work hardening program, training, and medical management.	Not Reported	CTDs decreased from 47.8 per 100 workers (1987) to 17.2/100 workers (1990) and 17.7/100 workers (1991).	OSHA Site Visit Case Study No. 2 (26-1175)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
235	Turkey Processing	2015	Each employee is involved in applying ergonomic principles with those designated as Employee Ergonomic Specialists receiving training. Company is providing support for the program in the form of capital, time, human resources, and technical support. Job duties are ranked on an ongoing basis by the Specialists. Each year one high-stress task is targeted for modification in one or more of the following: reduction or elimination of the manual task through automation, obtain additional material handling equipment, modify the work station, and increase staff while other options are being implemented. It is the company's policy to use rotation on a limited basis and instead opt for reducing or eliminating the ergonomic hazard. Supervisors and managers have the authority to make immediate decisions for the removal or correction of ergonomic hazards.	From 1995 to 1997, this large processor cut their ergonomic-related lost-work-day injury rate by 50% and their total lost -work-day injury rate by more than 40%.	Not Reported	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
256	Poultry Processor	2015	Initiated a corporate-wide ergonomics program in 1990 consisting of a comprehensive set of core program elements, including management commitment; employee involvement on joint labor-management ergonomics committees; training of employees and supervisors; evaluation of problem jobs by the ergonomics committee followed by implementation of control measures (some "quick fix"); identification of problem jobs using OSHA recordable MSDs and responding to employee reports of symptoms associated with musculoskeletal disorders; seeking worker input on the nature of problems with their jobs and possible interventions; medical management for employees with musculoskeletal disorders; and an annual evaluation of the entire ergonomics program.	Five years after initiation of the program, the incidence of workers' compensation claims for upper extremity MSDs fell by 46% and severity of the claims (cost of claim per 200,000 work hours) fell by 20%.	All repeated trauma cases, recordable on OSHA 200 logs, dropped from 5.55 in 1991 to 3.77 per 100 employees while the incidence of repeated trauma cases with days away from work fell from 0.73 per 100 workers in 1991 to 0.51 in 1994.	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (Jones 1997). (Ex:32-339-1)
291	Poultry	2015	Instituted a corporate ergonomics program which utilizes ergonomic committees. Key elements included training, work site analysis and task design, and a medical management process.	Not Reported	46% decrease in upper extremity MSD rates over a five-year period.	Testimony of Bradley Evanoff, MD, MPH. (Ex. 37-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
372	Poultry Slaughtering Employees	2015	Established a comprehensive ergonomics program which consisted of; awareness and training, medical management and early intervention, employee involvement, identification of high risk jobs, engineering and administrative controls, and job conditioning.	In three years from the time the ergonomics program was initiated, workers compensation costs were reduced by two-thirds. Total lost workdays were practically eliminated.	In three years from the time the ergonomics program was initiated, workplace injuries due to cumulative trauma disorders were reduced by two thirds.	(Ex. 502-404)
310	Poultry Processing Plant.	2015	A back-injury reduction program was initiated. This is an ongoing continuous improvement effort in ergonomics.	Not Reported	An 80% reduction in back injuries was achieved over a 4-year period.	(Ex. 500-114)
6	Poultry Processing	2015	Implementation of an ergonomics program, including redesign of processing lines, use of rubber-matted stools and platforms of varying heights to eliminate awkward reaches, worker training, and job reassignment for injured workers.	Not Reported	Decline in upper- extremity and neck/shoulder injuries from about 32 per month to 0.	Farr (1991) (Ex. 26-1044)
135	Poultry Processing	2015	In 1989, the company established a comprehensive ergonomics program at their mill. That program was later strengthened and its major program elements were: ergonomics training and education; medical management, including an emphasis on early reporting; employee involvement and identification of high risk jobs, hazard analyses of them, and implementation of engineering and/or administrative controls for them.	Within three years of initiating their comprehensive ergonomics program, not only were ergonomic related injuries down, but the productivity of their employees was up, the quality of their products had improved, their employee turnover rate had been cut in half, and their comprehensive health care costs had decreased 280%.	Not Reported	*Broiler Industry*, (February, 1992). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
202	Poultry Slaughtering	2015	In 1990 the company established a comprehensive ergonomics program at one of their plants. The major elements of their program were: *Ergonomic awareness training/education *Medical management/early intervention *Employee involvement/Ergonomic Committee & Task Forces *Identifying high risk jobs *Implementing engineering and/or administrative controls *Job conditioning	In three years from the time the ergonomics program was initiated, workers' compensation costs and workplace injuries due to cumulative trauma disorders were reduced by two thirds. Lost workdays were practically eliminated.	Not Reported	Correspondence, Perdue Director of Safety,(Nov. 17, 1994). (Ex: 502-22)
8	Poultry Processing	2015	Introduction of engineering controls: tool/handle redesign; work practice controls; administrative controls.	Not Reported	Recordable injuries and illnesses decreased from 10-14/100 workers (1988-89) to 7/100 workers (1991).	OSHA Site Visit Case Study No. 1 (Ex. 26-1174)
7	Poultry Processing	2015	Introduction of workstation analysis and redesign, including altering heights of products, providing workstands, and installing tank tilters to reduce manual handling. Program also included worker training and development of an integrated medical management/surveillance-analysis system.	Not Reported	Carpal tunnel incidence rates decreased from 7.8 per 200,000 hours to between 2.4 and 3.7 per 200,000 hours. Back injury rates declined from 4.4 per 200,000 hours to 3.0 per 200,000 hours.	Stuart-Buttle (1994) (Ex. 26-1045)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
193	Poultry Slaughterhouse	2015	A program following OSHA's red-meatpacking guidelines was initiatcd in 1992. An crgonomic committee was established in each department and meets monthly. Line supervisors were trained as trainers and trained their employees. A comprehensive medical management program with regular exams and modified work programs based on them was introduced.	Workers' compensation costs went from $.40 per work hour before 1992 to $.07 per hour now.	Carpal tunnel injuries, which averaged between 20 to 30 a year prior to 1992, have averaged less than 2 a year since then.	Douglas Rapp, Complex Safety Director, Tyson Foods of Monett, Phone Conversation:(7/13/99), (417) 235-9351. (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
191	Poultry Slaughtering	2015	The company brought in a professional ergonomics consultant to give them guidance on setting up a comprehensive program and to do a job-by-job ergonomic safety analysis of the facility. The consultant returns annually for a day-long program review. The training program is for new employees and is repeated once a year for all employees. It is a general overview that stresses the importance of early reporting. They established a medical management program and rely on two ergonomically-trained EMTs. They use job rotations at the first sign of symptoms. Job rotation is used routinely for some high stressor jobs such as deboning but due to employee resistance it is not widely used. They have a plant ergonomic committee to do ongoing job analysis.	Their ergonomic-related lost workday rate has gone from 86.9 in 1993 to 1.0 in 1998.	Their total recordable injury and illness rate has decreased 75% between 1993 and 1998. Their ergonomic-related incidence rate has fallen over 80%.	Spencer Cheak, Director of Human Resources and Safety, Marshall Durbin Food Corp., Hattiesburg, MS, phone conversation, (7/23/99), (205) 956-3505. (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
9	Ice Cream Manufacture, Various Jobs	2024	Performed job hazard analysis, implemented several controls including use of non-skid elevating platforms for shorter workers; modified workspace layout to permit workers to move without being hindered; replaced sharp edges of equipment with sloping angles or padding; replace hygienic thin-filmed gloves with warm, flexible gloves; modified way employees performed lifting and carrying tasks.	In 1985, before implementing the program, there were 4 compensation claims and absenteeism equaled 10 % of shifts worked. In 1987, there were no compensation claims and absenteeism was reduced to 4% of shifts worked.	Not Reported	Elie (OH&S Canada, Vol. 4, No. 7) (Ex. 26-1100)
10	Cattle Feed Processing Operation	2048	Provided a forklift and a bobcat to eliminate manual lifting and relocated the feed mixer in order to install chutes and augers to permit mechanical loading of feed. Installed bulk storage containers so that additives could be gravity-fed to the mixer. Constructed a platform under the auger equal in height to the truck platform, which allowed feed bags to be filled without manual lifting. Program also included providing lifting and handling training to workers.	Not Reported	The company eliminated manual handling injuries.	Teleki (1995) (Ex. 26-1046)
11	Bakery	205	Engineering controls: workstation redesign, tool modifications; improved work practices; formation of labor-management CTD committee.	Absenteeism related to carpal tunnel syndrome decreased from 731 lost work days (1987) to 8 lost work days (Jan.-Aug., 1991).	Carpal tunnel cases decreased from 34 (1987) to 13 (1990).	Robinson (1993) (Ex. 26-1102) (Ex. 38-65) (Ex. 32-339-1-1)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
162	Bakery	2051	They decided to use a homespun approach to implement a preventive ergonomics program. They brought in a hand surgeon to evaluate their procedures. They formed a joint labor management cumulative trauma disorder committee. Their assembly lines and the way the employees worked were changed. Conveyor belts were moved close to workers; pallets were also moved closer. Tables were raised and lowered; stools were added for employees who used to stoop; mats and foot rests were added. Preventive medical screening for early carpal tunnel syndrome was initiated.	Lost workdays almost eliminated. The company estimated they saved $750,000 annually on workers' compensation costs.	In three years after initiating the ergonomics program, carpal tunnel cases have been cut by 60%.	*Wall St. Journal,* (10/07/92) (Ex: 502-22)
12	Packaging Sugar Cubes	206	Cubes were packed tightly using a hand tool that required worker to exert considerable pressure on a sharp corner edge. Company changed marketing strategy that permitted cubes to be packed loosely, avoiding use of excessive hand force.	Considerable reduction in sickness absence and workers' compensation claims.	Serious strain injuries to hands were "virtually" eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 41
376	Chocolate Manufacturer	2064	The company determined that it needed to purchase eight different styles of scissors to eliminate employee pain.	Reduced workers' compensation costs by 90%.	Reduced its incidence rate of accidents by 55%.	(Ex. 502-404)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
240	Soft Drink Bottling	2086	For the last two years this small soft drink bottler has participated in OSHA's Consultation Program. This has given the company a background in occupational injury prevention through training. They began two years ago to track their occupational injuries by both type and department to help them identify their workplace risks.	Since 1996, they have reduced the number of lost work-days associated with them by 60%.	As a result of implementing some parts of an ergonomics program, since 1996 they have cut their rate of ergonomics related injuries by 40%.	OSHA case file (Ex: 502-22)
190	Catfish Processing	2092	To reduce MSD injuries, this company purchased ergonomic tools/knives, mechanical conveyors and lifts and automated stressor processes. The company also began rotating and enlarging jobs.	The work-related musculoskeletal disorder lost workday injury incident rate was reduced from 136.9 in 1990 to 4.3 in 1994.		Delta Pride corporate settlement agreement report to OSHA. (Ex: 502-22)
144	Snack Chip Manufacturing	2096	The company implemented a comprehensive ergonomics approach which included the elements of a good program.	From 1996 to 1997 the ergonomics program implemented by this employer reduced the lost work-days associated with back injuries by two thirds, and the rate of upper extremity musculoskeletal disorders and the number of lost work-days associated with them by more than 50%. In 1998 these rates are continuing to decline.	This resulted in a dramatic reduction in musculoskeletal injuries and illnesses.	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
148	Tortilla Production	2099	Ergonomists from their insurer and from OSHA helped the company set up an ergonomics program and evaluate their workplace. Engineering changes were made. Foot rests were used. Table heights were altered. Stools were provided. Employees were rotated to different work stations. Light duty tasks were made available to get injured workers back to work. Communication between management and employees was improved. An ergonomic training program was provided and a medical management program established.	Within two years the company's total losses plunged over 200 percent. Their loss ratio went from 217% to 9.2%.	Not Reported	Idaho State Insurance Fund Newsletter (Ex: 502-22)
221	Textile Manufacturing	22	The company replaced wooden chairs with adjustable padded swivel chairs. The company also adopted a medical program focused on prevention, early intervention, treatment and rehabilitation of MSDs.	Not Reported	The ergonomics program led to a drop in the MSD incidence rate from 12% in 1984 to less than 1%. Workplace changes also resulted in significant reductions in tendinitis.	Diverse Work Force Posing New Challenges in Designing Ergonomic Workplaces, Group Told," *Occupational Safety & Health Reporter* - Special Report, (November 7, 1990). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
330	Textiles	22	Hired an ergonomics professional and a physician practice. Ongoing training, workplace surveys and employee interviews to identify problem jobs, all complaints investigated, problem jobs are targeted for ergonomic improvement and redesign.	The lost workday injury rate was reduced from 14.6 in 1990 to 11 in 1992 (25% reduction).	Employee complaints concerning hand pain decreased from 34 in 1991 to 14 in 1992 (59% reduction).	(Ex: 32-339-1-1)
140	Textile Manufacturing	22	The company formed joint management-labor safety and health committees that identified and eliminated safety and health hazards. The joint committees developed solutions such as springs for the material-handling boxes so yarn remained at a comfortable level, eliminating the need for workers to bend down and lift up material. Workers designed and management implemented a new improved bagging system. The company also purchased adjustable chairs.	Not Reported	There were 121 work-related musculoskeletal disorders and 19 back injuries in 1993. After three years of the ergonomics program, there were only 21 work-related musculoskeletal disorders and one back injury.	Workshop on corporate-wide settlement agreements, (March 24, 1999), Washington, D.C. (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
222	Knitwear Manufacturing	225	The company launched its ergonomics program in 1991 by focusing on educating all employees on ergonomics risks. In some plants, The company installed new equipment, such as vacuum waste-removal attachments and fully adjustable chairs. The company spent $2 million to automate one assembly process by developing an automated chain-stitch machine. Less costly changes included repositioning label holders by 15 degrees to match an operator's hand movements.	The company's ergonomic changes have resulted in a 40% reduction of injury claims costs since 1991.	Not Reported	John W. DeWitt, "Ergonomics: Bigger is Better," Apparel Industry Magazine, (5/1/1995). (Ex: 502-22)
142	Weaving of Carpet Backing	2273	The company used OSHA's draft ergonomics program guide as the basis to improve the ergonomics program they had established in 1994. They have a yearly ergonomic training program and strongly emphasize early reporting. Ergonomic job analyses are triggered by workplace incidents and pro-active reviews.	Not Reported	They have achieved more than a 50% decrease in ergonomic-related injuries and illnesses.	James Pair, plant manager, Amoco Fabrics and Fibers Phone call: (912) 375-6520; (7/14/99) (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
336	Manufacturing	23	They use a quick-response team charged with performing: *correct work station adjustments, * follow up to assure actions are effective, * obtain medical care to treat objective or subjective symptoms, * make improvements in current tools and equipment, * instruct in proper work techniques for affected individuals.	For the time period of 1998 to 1999, the total number of illness cases increased by 15% while the number of lost-time-days dropped by 47%, and the number of restricted days dropped by 23%.	Not Reported	(Ex. 32-198-4-28)
143	T-Shirt Mfg.	23	Analysis by professional ergonomists and safety and health engineers identified that strain injuries (mostly cumulative trauma disorders of the hand, wrist, arm and back) accounted for 68% of the claim injuries and 88% of the claim dollars. They identified their three primary issues as: ergonomics, injury management, and safety training. They trained their supervisors and employees to observe people as they were working and to observe their posture. They showed their employees how to adjust the height of their chairs, the height of their work tables, and the height of their sewing machine motors. They trained them on the importance of maintaining proper ergonomic body postures.	The company achieved an 85% reduction in workers' compensation costs seven months after establishing a comprehensive safety and health program that stressed ergonomics.	Not Reported	*Occupational Safety and Health,* (October, 1995) (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
141	Manufacturing Baby Products	23	The company's ergonomics program includes a committee that tries to assess the "operator-friendliness" of each process in assembly, and then implements the most ergonomic way of doing each task. The committee also trains operators to perform lifts and other risky operations. Workstations are continuously evaluated, and new types of adjustable, tilt-forward chairs have been purchased.	Not Reported	From 1993-1995, injury rates dropped from 11% to 7%, along with significant improvements in productivity and quality.	John W. DeWitt, "Ergonomics: Bigger is Better," *Apparel Industry Magazine,* 5/1/95 (Ex: 502-22)
347	Athletic Apparel Manufacturer	23	Implemented measures such as a 75% reduction in piecework compensation to reduce potential for MSDs through over-use, cross-training to reduce repetitive motions, ergonomic chairs to fit the workstation, and a contractual agreement with health care provider.	In the last 6 months, production has slowed considerably as a direct result of cross-training and almost eliminating piece-rate practice. Went from 54 pieces per day to 45 (17% reduction). Had to hire more staff to meet demand, resulting in increased costs.	Not Reported	(Ex. 30-1861)
388	Sewing Machine Operators	23	Incorporated adjustable table and chairs, increased size of work tables and lowered sewing machines.	Increased sick leave.	Did not see any reduction in MSD's.	Westgaurd et. al. (1986) (Ex: 38-68)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
164	Apparel Mfg.	23	The company hired outside consultants and developed an in-house database to isolate problems and devise specific solutions, including new equipment. The company also implemented formal ergonomics committees, typically comprised of the plant engineer and five to ten associates. Committee membership rotates periodically to get more staff involved.	In 1995, the company's lost time days dropped by 53%, and workers' compensation costs dropped 55%.	Not Reported	John W. DeWitt, "Ergonomics: Bigger is Better," *Apparel Industry Magazine,* (5/1/95). (Ex: 502-22)
174	Apparel Mfg.	23	The company used OSHA 200 logs, workers' compensation data and videotapes of jobs to analyze ergonomic problems. Once the issues were identified, the company used an ergonomics design team, consisting of an ergonomics specialist, a standards analyst/engineer, an occupational health nurse and a member of the maintenance department to create solutions. The team redesigned several aspects of the company's workstations, concentrating on excess force, angle problems, repetitions, and awkward unsupported postures.	The company reduced lost-time incidents due to MSDs by 79%.	Not Reported	Rooney, E.F. & Morency, R.R., A Practical Evaluation Method for Quantifying Ergonomic Changes at L.L. Bean, Advances in Industrial Ergonomics and Safety, IV, S. Kumar, Taylor and Francis, (1992). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
231	Clothing Manufacturer	23	This company created a task force to identify and address the ergonomics problems. As a result, the company invested in new equipment including padded and adjustable chairs. The safety team was authorized to purchase new chairs for each person on the production line. The company engineers developed air-driven tools to eliminate forceful exertions. The company installed mechanical feeds at some workstations to reduce the amount of force required to push material through the machine. The company trained its staff in ergonomics and encouraged employees to report injuries. The task force established job rotations that allowed employees to vary their work throughout the day.	In 1993, workers' compensation costs declined to $2.7 million, a 33% reduction.	Not Reported	Taking Control of Your Workers' Comp Costs," *Fortune*, (October 1994). (Ex: 502-22)
264	Window Manufacturer	2431	The company's program consisted of job-site assessments to identify hazards, training, modifying work areas or tasks to reduce repetitive body motions using ergonomic aids such as wrist supports, and early intervention by reacting aggressively to the first symptoms of repetitive strain injuries or carpal tunnel syndrome.	The employer received a $250,000 rebate on their workers' compensation premium, and saved as much as 75% in medical costs by intervening early using physical therapy rather than surgery.	The company was having an average of 22 carpal tunnel syndrome surgery cases every year. Following implementation of the program, carpal tunnel syndrome surgeries averaged one case per year.	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (Strakal, 1994). (Ex:32-339-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
192	Bath Vanity Furniture Maker	2511	The company adopted ergonomic changes to decrease injuries. These included dropping the conveyor belt so workers had easier access to the tops of cabinets, installing conveyors to minimize manual lifting, purchasing angled tables to reduce bending and reaching and rotating jobs every two to four hours. The company also included training videos and safety training in its ergonomics program.	Ergonomic changes resulted in a decrease of almost 40% in workers' compensation costs, with workers' compensation costs declining from $103,824 to $61,000.	In 1996, there were only four recordable injuries.	Ergonomics: Effective Workplace and Best Practices Conference, Chicago (1997), NIOSH Proceedings (Ex: 502-22)
15	Mattress Manufacturer, Warehousing	2515	Added conveyor, increased fork truck use, reduced stacking heights, and revised handling procedures. Production process changed to eliminate material handling and loading onto truck.	Not Reported	Decreased injuries from 9 to 1 in one year.	Marcotte (undated) (Ex. 26-1048)
13	Mattress Manufacturer, Material Handling	2515	Introduction of hand trucks and lift systems to aid in manual handling. Job hazard analysis involving the employees in identification of problem areas and solutions to problems. Job hazard analysis of all job functions to resolve ergonomic problems. Modified workstations, tools, and manufacturing procedures.	53.5% reduction in workers' compensation reports in one year (1991).Lost time reduced 1/4 to 1/3 in 3 years.	Not Reported	Bedtimes (1992) (Ex. 26-1047)
17	Office Furniture Manufacturing, Various Jobs	252	Installed scissor lifts to aid in packaging file cabinets of different sizes. Small-assembly workstations were altered to eliminate twisting and bending during lifting.	Not Reported	Back injuries have been cut by 50 percent.	LaBar (1991) (Ex. 26-1078)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
16	Office Furniture Manufacturing, Various Jobs	252	Introduction of a plant ergonomics program employing engineering controls, work practice controls, administrative controls, medical management, and education and training.	Restricted workdays decreased from 301/100 employees to 221/100 employees.	Decreased rate of MSDs from 21/100 employees (1989) to 19/100 employees (1991-1992).	Robinson (1993) (Ex. 26-1102)
182	Office Furniture Manufacturing	2522	The focus of this company's ergonomics program has been on fixing jobs so work does not have to result in pain. They target avoiding stretching and reaching stresses by arranging assembly areas so parts are readily accessible. Their medical management program includes having a mini-hospital at the company for immediate medical attention.	The company's Grand Rapids plant has achieved a very low lost-time injury rate of 0.8 per 100 workers because of their focused ergonomics program.	Not Reported	Safety and Health, (November, 1990). (Ex: 502-22)
168	Pulp and Paper Manufacturing	26	This employer chose to focus their ergonomics program on training and the physical aspects of their workplace and work processes.	Three years after being invited to join the Maine 200 Pilot program this mid-sized pulp and paper mill's ergonomics program had cut their lost work-day injury incidence rate by over 50%.	Not Reported	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
18	Pulp and Paper Mill Workers	2621	Conducted training sessions covering CTD issues and hazardous postures at the workplace. Job analysis included interviews of employees. Program included strengthening exercises and fitness initiatives. The following engineering controls were implemented: • reduced the number of wires per bale to reduce weight, • use of padded bolt cutter handles, • provided better lifting devices.	Not Reported	In a six-month follow-up to the interventions, the CTD rate had been diminished to zero and there were no wrist and elbow problems.	"Avenor's fitness a warm-up to ergonomics." CTD News (1996) (Ex. 26-1050)
356	Paper Mill	2621	In 1990, the company established a comprehensive ergonomics program. In particular, they installed mechanical handling and lift equipment; added ergonomic tools, chairs and inspection stations; automated and redesigned production process; and instituted job-sharing and mandatory breaks.	Not Reported	Within three years of starting their ergonomics program, their musculoskeletal disorder injury incidence rate was cut almost in half, going from 9.12 in 1990 to 5.15 in 1993.	(Ex. 502-404)
312	Manufacturing	2670	Most successful elements of their program: * Management participation in identifying and prioritizing issues, * Procedures were developed to identify hazards and make an assessment, * Team of managers, employees, technicians, etc.. who understand MSDs, * Appropriate medical information and treatment made available.	From 1993 thru 1997, they experienced a 70% reduction in ergonomic - related lost time OSHA recordables.	They realized that approximately 50% of all their OSHA recordables were WMSDs. From 1993 thru 1997, they experienced a 50% reduction in ergonomic-related OSHA recordable's.	(Ex. 30-3185)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
133	Personal Hygiene Products	2676	The company implemented a medical management program using a medical management team. The team handled worker training and education, hazard prevention and control and worksite analysis.	Early reporting led to an initial increase of 5% in MSD cases at one plant from 1992-1994. However, early identification, treatment, and control for problem jobs reduced workers' compensation costs by 35%. Average costs per case also fell to $1,400 from $8,000.	Not Reported	"Employers Report Reduced Cost Due to Workers' Compensation Initiatives," *Employee Benefit Plan Review,* (March 1998). (Ex: 502-22)
20	Printing, Glue Machine Operators	27	Installed partial mechanical aid for off loading of cartons.	Not Reported	No injuries reported in 2 yrs since changes.	Shinnick (1985) (Ex. 26-1049)
367	Newspaper	2711	Implemented an ergonomics program that included work site and work process evaluations, workplace redesign and renovation, training, on-site medical management, ergonomic equipment, a computerized tracking system and an in-house telephone hot line.	Over a four-year period (1992-1996), the company's efforts resulted in an 84% drop in the number of MSD workers' compensation cases, a 75% drop in lost-time cases and a 91% decrease in total days lost.	Not Reported	(Ex. 502-404)
120	Newspaper Publishing	2711	Company purchased adjustable workstations for their staff. They trained their employees on how to prevent injuries, encouraged early reporting of injuries and discomfort, and required keyboarders to take mini breaks. They also formed a labor-management task force to recommend changes in workstation design. They appointed a VDT safety coordinator to address concerns they may have about repetitive motion injuries and write an ergonomics column for their monthly in-house newsletter.	Of the 24 carpal tunnel cases in the year before program implementation, 12 involved lost workdays, and workers' compensation costs exceeded $250,000. Three years later there were no lost workdays, and workers' compensation costs were only $6,000.	The year before they started their office ergonomics program, they recorded 24 carpal tunnel cases - five required surgery. Three years later they had 13 cases, none involving surgery.	*Business and Health,* (May 1995). (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
326	Newspaper Industry (Three-establishments)	2711	Program developed over 3 phases. Phase 1, the detection phase consisted of determining the prevalence and extent of work related MSDs. Phase 2, the intervention phase consisted of implementation and evaluation of participatory ergonomics program. Phase 3 the information dissemination phase involved the development of training materials.	Not Reported	The incidence rate of cases on the OSHA 200-log associated with MSDs of the upper extremity, neck, and low back decreased approximately 40% in the first two years of implementation.	Testimony of Rosecrance (Ex: 37-26)
232	Book Assembly	2732	The company installed 33 automatic, air-operated pallet positioners with rotating tops, activated by a simple charge.	Not Reported	After installation of the pallet positions, recorded back injuries dropped from 37 to 12.	Tom Feare, "Better Ergonomics: It's the Law," Modern Materials Handling, (6/1/94). (Ex: 502-22)
233	Commercial Printing and Lithography	2752	The company decided to implement a comprehensive ergonomics program. They started with ergonomics training focusing on how musculoskeletal injuries occur in the workplace, how to identify the risk factors, how to recognize the early signs and symptoms, workplace biochemechanics and the importance of early reporting. They formed employee management teams in their high risk areas and charged them with identifying ergonomic stressors and potential controls.	Four years after this commercial printer had initiated a comprehensive ergonomics program, their lost workdays were reduced by 60 percent and their associated workers' compensation costs by 10 percent.	Not Reported	Correspondence with OSHA. (October 16, 1998). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
21	Book Binding Operator	278	Introduced industrial load leveler (a spring loaded table) for loading/unloading pockets, binders, stitchers, and off-line mailers.	Lost workdays fell from 413 to 112.	Not Reported	Ferris (1992) (Ex. 26-1051)
132	Petroleum, Chemicals, and Pharmaceuticals	28	The company decided to strengthen their comprehensive ergonomics program and begin compiling separate injury and illness statistics for their ergonomics-related cases. Their program uses ergonomics teams to encourage employee participation. They focus on incremental workplace improvements as well as major process changes. Early reporting of symptoms or pain is an important part of their medical management program. Employee involvement on teams analyzing ergonomically stressful jobs is utilized.	Since 1993 when they began tracking injury and illness statistics for ergonomics-related injuries separately, their ergonomics program has produced significant declines in both ergonomics-related injuries and lost work time.	Not Reported	Safety and Health, (February, 1996). (Ex: 502-22)
252	Chemical Manufacturing	28	Targeted several divisions with the highest rates and conducted ergonomic evaluations for jobs in those divisions. In the acetate fiber division, several solutions were developed to reduce forceful exertions and repetitive motions. Those solutions were successful and enabled the ergonomic program to expand to other areas.	Over 5-year period, reduced the number of MSD-related workers' compensation cases by 58%.	Over 5-year period, reduced the number of OSHA recordable MSD's by 82%.	CTD News, Volume 7, No. 1, 1998. (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
22	Organic Chemical Manufacture, Manual Handling	283	Analysis of injury data, observation of material handling tasks. Installed materials handling equipment, automated container-packaging and inspection equipment. Reduced weight of bags and drums. Worker training program.	Severe back injuries resulting in lost workdays were eliminated (1979-1989).	62% reduction in the incidence of total overexertion back injuries.	Ridyard (1990) (Ex. 26-1052)
368	Pharmaceutical/ medical Plastics Manufacturing	283	Installed an overhead crane system with two bridges and an air-powered balancing hoist suspended from each bridge. The crane now lifts the rolls of web film.	Not Reported	No workers have experienced back injuries on this operation in the two years since the crane has been in use. Lifting injuries still occur, but the numbers are down dramatically and none are attributable to loading rolls of film into the packaging machinery. Productivity has increased and morale has improved.	(Ex. 502-404)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
155	Pharmaceutical Manufacturer	283	In 1993,the company worked with its office furniture vendors to develop a two-week training program to educate 1,000 of its office workers about the safest way to do their jobs. Approximately 30 employees received 8 additional hours of training to become ergonomics coordinators. In addition, nonadjustable steel seats with steel back rests were replaced with cushioned, adjustable chairs, and a conveyor belt was redesigned to automatically feed bags into a heat sealer.	By 1995, two cases of repetitive motion illness resulted in only 34 lost workdays.	Cases of back disorders had dropped by 87%.	Meg Fletcher, "At Baxter, Furniture Helped Sell Workers on Ergonomics," *Business Insurance*, (4/22/96, p. 141); Sarah Wortham, "Let Your Workers Lead the Way," *Safety and Health*, (7/98, p.66); Sally Turner, "Ergonomics Teams: Help Workers Help Themselves," *Safety and Health*, (2/96, p. 54). (Ex: 502-22)
153	Pharmaceutical Preparation	2834	Using information from employee surveys and computer analyses, the company redesigned the work process to reduce lifting from floor level by 80%. The company installed power straddle lifts and power-flex conveyor systems. It replaced metal filter press plates weighing over 60 pounds with plastic frames that weigh15 pounds.	With the change in work processes, by 1994, lost time accidents had decreased from 66 to 4 and workers' compensation losses decreased ten-fold.	Total recordable injuries decreased from 156 to 60.	Company's correspondence to OSHA (November 10, 1994). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
219	Pharmaceutical Preparations	2834	Created the Ergonomics Task Force in the fall of 1994, consisting of nine members--an ergonomist, engineers, and specialists in logistics and occupational nursing. The Task Force's goal was to establish trained ergonomics teams in each of the firm's 132 U.S. facilities; to conduct training courses for a core group of designers, project engineers and principal engineers; and to address the ergonomic needs of workers using VDTs, plant maintenance workers and employees in the custodial and kitchen staffs. On site, teams analyze jobs, identify hazards, suggest corrective actions, and define ergonomic characteristics of individual jobs to appropriately place workers with medical restrictions. Teams are provided with basic skills for evaluating and setting hazard priorities, and making job site assignments.	Not Reported	Divisions have eliminated cumulative trauma disorders or reduced them by as much as 75%. Savings in the six digits due to productivity improvements, labor savings, and reductions in workers' compensation costs are also commonly reported outcomes.	Ergonomics News, (October, 1995). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
23	Paint Manufacturing	2851	Top management actively supported safety and health programs and communicated this commitment to all employees. The company considered ergonomics issues when it investigated accidents and redesigned work processes to eliminate hazards. Safety and health programs became an integral part of the engineering and manufacturing departments. The company relied on medical management to identify ailments before they became serious and to pinpoint job tasks with ergonomic risks.	From 1990 to 1993 Akzo Coatings lost work time rate decreased approximately 63%; its workers' compensation costs declined by 50%.	OSHA recordable injury/illness dropped by 40%.	(Ex. 502-22) (Ex. 26-1054)
25	Oil Refinery, Handling Hoses and Valves, Manual Handling	2911	Added platforms that make valve access easier, added extensions to valve stems to eliminate bending to turn valves, installed hoists over work tables to eliminate lifting and bending, purchased adjustable height carts, upgraded lighting, and conducted back injury training.	Not Reported	Injury rates dropped by 90%.	Bone (1993) (Ex. 26-1055)
272	Rubber and Plastics Part Manufacturer	30	Ergonomics training and intervention program introduced. Added material handling equipment, workstation modifications to eliminate postural stresses.	Total lost time at two plants reduced from 4.9 and 9.7/200,000 hours to 0.9 and 2.6 over a four year period.	Not Reported	"Summary of Studies on the Effectiveness of Ergonomic Interventions" (June 1995). (Ex. 38-65)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
352	Hardware Manufacturing	30	The company decided to completely eliminate manual lifting at its worksite. Each worker was provided a lift-table/transporter to lift and move materials.	The company was paying $88,400 in back injury claims. Injury costs have declined to $8,700, about 10 percent of the previous cost. The lifts increased productivity, because they enabled employees to work more quickly and efficiently.	Injuries have been reduced by 90%.	(Ex. 502-404)
362	Tire Manufacturer	3011	Developed an ergonomics program which includes the following elements: a written program, collection and evaluation of illness and injury data; job hazard analyses; engineering and work practice controls; new equipment review; employee training; and medical monitoring.	After implementing an ergonomics program in 1997, this mid-sized manufacturer saw their total lost-time injury rate fall by 40% in 1998. Their lost-time back injury rate and upper-extremity musculoskeletal disorders declined by 66% in the same period, and the work days lost associated with each by 80%.	Not Reported	(Ex. 502-404)
26	Rubber Hose Manufacturing	3052	A new hand tool was designed (an air gun) that is counterbalanced to reduce the amount of weight supported. This tool also has better handles.	No lost time incidents from repetitive trauma since the new tool was introduced.	Not Reported	Oxenburgh (1994) (Ex. 26-1041), Case 7

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
147	Plastic Parts Manufacturing	308	In order to address the shoulder, arm and wrist injuries that were occurring due to hammering on molds containing plastic parts, MA purchased new molds that have made part removal easier. They also instituted a rotation policy for those departments with high levels of repetitive motion stresses.	In 1997, by adopting some straightforward ergonomic controls this mid-sized manufacturer reduced their work related lost time injury rate by 40%, compared to 1996 levels. The number of associated lost work-days was also cut from 259 to 61. As of October 1998, the department with the worst ergonomics related injury experience in the previous year had yet to record a single incident.	Not Reported	OSHA case files (Ex: 502-22)
263	Foam Products Manufacturer	3086	In response to the cumulative trauma injuries, the employer instituted an ergonomics program that included management commitment, medical management, training, creation of an ergonomics committee, identification of hazards, job analysis, and implementation of control measures.	Lost workday cases fell from 35 to 1; and cumulative trauma cases decreased from 34 to 6 from 1990 to 1993.	During the four-year period following the initiation of the ergonomics program, covering 1990 to 1993, all recordable injuries dropped from 128 to 18.	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (Whaley). (Ex:32-339-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
27	Shoe/luggage Manufacturing, Various Jobs	31	Instituted a comprehensive ergonomics program as part of a total quality management initiative. Program included elements of worker participation, medical management, job analysis and control of exposures to risk factors, and employee education and training. Exposure controls included installation of adjustable workstations; new jig fixtures to hold work pieces at proper angles; partial automation of processes; and use of anti-skid surfaces on tools, fixtures, and handles.	Reduced lost time upper extremity and back disorders by 79%.	Not Reported	Rooney and Morency (1992) (Ex. 26-1056)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
29	Shoe Manufacturer, Various Jobs	314	Several programs implemented that included exercise and conditioning, stretching, and ergonomics awareness training. Conducted special training on ergonomics for industrial engineers and maintenance workers. Continuous flow manufacturing, including group working, cross training, and job rotation, was instituted. Engineering controls implemented included: • Purchase of new adjustable chairs; • Use of anti-fatigue mats for all employees whose jobs involved prolonged standing; • The cast iron base on heavy equipment was cut off and refitted with an adjustable base; • Electric or pneumatic foot pedals were used instead of non-adjustable mechanical ones; • Prepackaged shoe laces were purchased to eliminate hand-tying repetition; and • Sewing machines were tilted toward the worker to eliminate awkward posture.	Not Reported	Repetitive motion injuries in two problem areas were reduced from 70 percent to between 25 and 30 percent of the total OSHA recordable incidents in three years.	"Red Wing Shoes' early warning system." CTD News (1995) (Ex. 26-1057)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
30	Shoe Manufacture, Pneumatic Press Operator	314	Workstation design improvements included use of adjustable chairs and footrests, providing armrests, changing angle of the presses, providing parts bins to reduce extreme wrist flexion, and redesigning shoe ornaments so prongs were angled for easier insertion and pressing.	Not Reported	No injuries reported for 2 years since changes were implemented.	Wick (1987) (Ex. 26-1058)
31	Footwear Assembly and Fabrication	3149	Extensive ergonomic training program.	Lost-time injuries dropped 67% in 2 years.	Total number of CTDs dropped by 62% in 2 years.	Holland (1991) (Ex. 26-1059)
323	Luggage Manufacturer	3161	Ergonomics program consisted of: management leadership, employee participation, medical management, training, job-hazard analysis, problem-solving and intervention, cost-benefit analysis, solutions, specific interventions, and program/process evaluation.	A 73% reduction in combined total of lost and restricted work days due to MSDs from 1994 thru 1996. Went from a rate of 5.5 per 100 workers to 1.5 per 100 workers	In four years there was a 87% reduction in incident rates of MSDs reported on the OSHA 200 log from 40 in 1993 to 5 in 1997.	Testimony of Rosecrance (Ex. 37-26)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
127	Luggage Manufacturer	3161	The company has a total of 2,500 operations. The company prioritized problem jobs based upon lost time and the citation associated with the fine. Samsonite identified 450 jobs to fix. The company began analyzing jobs and working with its medical staff to treat workers earlier and get injured workers back to work more quickly. Many controls proved to be inexpensive fixtures costing less than $45.	Not Reported	When OSHA cited the company, its injury rate for work-related musculoskeletal disorders was about 40 injuries per 100 workers. By 1997, the rate had dropped to 6.5 injuries per 100 workers.	Presentation at the Ergonomics Symposium: Effective Workplace and Best Practices Conference, Chicago (1997), NIOSH proceedings. (Ex: 502-22)
32	Sewing and Cutting Operations	3199	Introduction of ergonomics program, including medical program to detect and treat CTDs early. Workplace modifications included use of adjustable workstations, footrests, and anti-fatigue mats; installing larger handles on hot irons to improve grip; installing proximity switches on presses; adjusting glue stations to prevent awkward upper-extremity postures; and automating some processes.	Not Reported	CTD incidence fell from 14.6% in 1990 to 11% in 1992	Nickasch (1994) (Ex. 26-1060)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
33	Encapsulating Automotive Glass Windows	3229	Ergonomics program and control measures, including installation of adjustable workstations, job rotation, and anti-fatigue matting; medical management program and an employee training program.	Incidence of lost-work-day injuries declined from 8.6% to 0.2% in 2 years. Rate of lost workdays declined from 1,615/100 workers (1990) to 0.9/100 workers (1992).	Not Reported	OSHA Site Visit Case Study No. 12 (Ex. 26-1182)
34	Packager	3231	Workplace improvements included: Reduced all material handling to less than 50 pounds; Purchased different sizes of gloves, cuffs, and sleeves to reduce additional stress and energy expenditure; Designed a device that allows employees to roll the glass onto the line instead of lifting it; Raised the racks to knuckle height to avoid bending while lifting the windshields; and Altered the racks to allow workers to step into them and load them from back to front in order to eliminate stressful forward reaches.	Not Reported	Injury incidence rate dropped from 14 per 100 workers in 1987 to 3.3 in 1996. Reduced severity and frequency of injuries.	"PPG learned to overcome ergo innocence." CTD News (1996) (Ex. 26-1061)
35	Ceramic Tile Manufacturing, Various Jobs	3253	Implementation of an ergonomics program including engineering controls (workstation redesign), job rotation, changes in work practices, and an ergonomic training program for employees.	Lost-time injury rate for repetitive motion injuries decreased from 1.6 in 1988/1989 to 0 in 1993.	Not Reported	Stuart-Buttle (1994) (Ex. 26-1045)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
241	Ceramic Fixture Manufacturing	326	This company has implemented the following controls: The work heights of some processes have been redesigned to reduce stresses associated with vertical lifts. Mechanical lift assists have been added to the casting department and training on safe lifting techniques has been provided by their workers' compensation insurance carrier.	This small manufacturer has reduced the number of lost/restricted work-days associated with ergonomics related injuries in their workplace by 60% for 1997/1998 (combined).	Not Reported	OSHA case files (Ex: 502-22)
36	Fiber-cement Board Manufacture, Manual Handling	3272	Installed on-loader at front of conveyor to permit workers to load boards at their own pace. Automate process for separating boards and transferring them to the on-loader. Automate stacking of final product.	Eliminated lost-time MSDs in 2 years after improvements were made.	Not Reported	Oxenburgh (1994) (Ex. 26-1041), Case 11
37	Metal Castings, Unpacking Operation	33	Frequent, excessive reach was required to unpack 15- to 18-pound castings from crates. Crates were modified by adding drop gates at each end of the crates and installing a scissors lift to lift crates. In addition, changes were made in the way the castings were stacked in the crates to permit the workers' arms to remain close to the body while unpacking.	Not Reported	Eliminated back injuries associated with this operation.	Oxenburgh (1994) (Ex. 26-1041), Case 34
38	Palletizing Operation	33	Scissors lift tables with turntable tops were installed alongside each packing station.	Not Reported	Five out of six back injuries were eliminated.	Benson (1987) (Ex. 26-1062)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
306	Metal Manufacturer	33	Started by implementing a shor-t term ergonomics plan. Implemented a adjustable lift-table and mechanical handling equipment as well as improvements to a punch press.	Over a 2-year period, they had 2 serious back injuries with direct costs of $30,000. New equipment cost $5,000, and since installed there here been no injuries.	Not Reported	(Ex. 500-114)
112	Gray and Ductile Iron Foundry	3321	In 1997, the company performed a survey to identify problem areas. They instituted an ergonomic awareness program and conducted safe back training. The company also purchased anti-vibration gloves.	The severity rate of injuries, as reflected in the associated lost work-day experience, was also dramatically reduced.	From 1996 to 1998 this employer cut their overall work related injury and illness incidence rate by 60% and their ergonomic related injuries even more.	OSHA case files (Ex: 502-22)
348	Aluminum Smelter	3341	Reduced the exposure time for carbonsetters by half for a number of risk factors such as handling heavy loads, pinching, and awkward postures of the wrist, forearm and shoulder. There was a 1/3 reduction in the duration that workers were exposed to awkward trunk postures.	Not Reported	They achieved a 50% reduction in prevalence of shoulder, elbow, and back disorders for carbonsetters. Hand and wrist disorders were reduced by 1/3.	(Ex. 500-41-3)
39	Aluminum Manufacturer, Materials Handling	3350	Establishment of an ergonomics program, including introduction of lift tables, cranes, and mechanical assists in overhead lifting, rearrangement of work to allow use of cranes in lifting.	Not Reported	Reduced overexertion injuries of the back by 40 to 60%.	Mandelker (1993) (Ex. 26-1063)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
261	Cable Manufacturer	3357	Ergonomics interventions were initiated in 1975.	A statistically significant decrease in average musculoskeletal sick leave, expressed as a percentage of total production time, dropped from 5.3% in the period of 1967 to 1974 to 3.1% in the years from 1975 to 1982. A statistically significant reduction in labor turnover also occurred in the period 1967 to 1974 compared to 1975 to 1982, attributable to the impact that ergonomic interventions had on improved health and job satisfaction among employees.	Not Reported	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (Westgaard. 1985). (Ex:32-339-1)
40	De-burring and Finishing Cast Metal Parts	34	Parts were held still by hand during finishing operations. Work bench was replaced by a potter's wheel to hold the part and rotate it as necessary. Finishing tools were redesigned.	Not Reported	Upper-extremity disorders were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 43
41	Welding	34	Manual welding of a 5-meter weld required welder to work in a prolonged static posture. This process was replaced by a semi-automatic powder welding process, permitting welder to work from a standing position.	Not Reported	All knee, neck, and shoulder injuries from this operation have been eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 33

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
42	Materials Handling, Hardware Manufacture	3411	Use of adjustable lift tables/ transporters completely eliminated manual lifting from the job.	Not Reported	Back injuries reduced by 90%.	"Put ergonomics to practical use." Material Handling Engineering (1988) (Ex. 26-1064)
205	Manufacturing-steel Fabrication	344	The company's approach included conditioning for employees returning to work following an injury, job sharing, and transitional job assignments. With the help of elected team leaders, everyone leaving and returning to work after injury or illness receives support and encouragement. Job modifications included ergonomic redesign to accommodate individuals with limitations.	Workers' compensation costs dropped from $200,000 in 1985 to just $9,000 in 1990. During the same five-year period, sick-day usage fell by half.	Not Reported	*Automation*, Volume 36, Number 4 (Ex: 502-22)
43	Packager	3452	Packaging area was redesigned; raised the level at which boxes are lifted, installed semi-automatic sealing machines and adjustable chairs, and eliminated loading of pallets; training introduced.	Nearly a five-fold decrease in musculoskeletal injuries based on days lost (equivalent to 5% of the department's total wage costs).	Not Reported	Oxenburgh (1994) (Ex. 26-1041), Case 10
44	Manufacturing Automotive Cables	3496	Introduction of ergonomics program utilizing engineering controls, work practice training, and medical management.	Lost workday cases decreased from 48 (1991) to 27 (1993). Number of lost workdays decreased from 1,287 days (1991) to 275 days (1993).	Decreased illnesses from 47 (1991) to 17 (1993)	OSHA Site Visit Case Study No. 11 (Ex. 26-1181)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
45	Steel Furniture Manufacturing, Various Jobs	3499	Employee involvement in identifying hazards and developing interventions. Engineering approaches included the following: • An enclosed shotblaster machine to automate polishing of the steel. • An automatic washing system. • Lighting placement and brightness improved to reduce the awkward posture required to inspect and brush the products. • Many of the jigs were improved to be adjustable.	Lost days from carpal tunnel syndrome, back strain and other CTDs dropped to zero in 1996, down from 176 lost workdays in 1991.	Not Reported	"Charleston Forge welds homemade approach." CTD News (1996) (Ex. 26-1065) Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" Ex:32-339-1 Success with Ergonomics (Ex. 26-1065)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
151	Equipment Manufacturing	35	The company decided it was time to hire an experienced health and safety manager who set up a comprehensive program emphasizing ergonomics. Ergonomic hazard assessments were performed of high risk departments. As a result many changes were made. Workers were provided larger knives and more adjustable work stations. Hourly job rotation was initiated. A medical management program was implemented to assure proper job fit for employees as well as to emphasize appropriate medical treatment and prompt return to work.	Workers' compensation insurance costs, which had exceeded $100,000 in 1993, fell to below $4,000 in 1997. In 1997, the company's lost-work day injury incidence rate fell to zero.	Not Reported	Business Insurance, June 22, 1998 (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
152	Machinery Equipment Manufacturer	35	The company introduced a major back injury prevention training program for employees and implemented many improvements suggested during the training. Minor changes to equipment and work stations reduced physical stress for employees and resulted in improved morale. Adjusting the heights of work tables, chairs and fixtures eliminated excessive employee bending and twisting. Workers developed new tool designs and introduced material handling equipment to reduce other lifting and repetitive motion hazards.	Not Reported	In 1990 the back injuries decreased by 27 percent.	*Welding Journal*, (September 1992). (Ex: 502-22)
171	Turbine Generator Manufacturer	3511	Both of these facilities chose to implement their ergonomics programs as part of comprehensive safety and health programs. Their programs stressed worker involvement. They added power lifting equipment and changed workstation designs to reduce strains to the arms that their employees were experiencing.	By implementing comprehensive safety and health programs strongly emphasizing ergonomic concerns, both of these facilities cut their rate of lost time injuries by more than 70% between 1992 and 1996.	Not Reported	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
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47	Farm Equipment Manufacture, Assembly and Materials Handling	3523	Initiated an eight-hour engineer ergonomics training program. Appointed ergonomics coordinators in all U.S. and Canadian factories, foundries and distribution centers chosen from the industrial engineering and safety departments. Conducted training through attending professional courses and conferences, memberships in professional organizations, subscriptions to ergonomics publications and tracking the latest ergonomics research. Conducted ergonomic review of new office furniture purchases. Conducted VDT ergonomics awareness training for video display operators. Engineering controls included: • Limiting manual lifting to 40 pounds or less; • Redesigning the assembling operations so that assemblers worked in an upright position; • Altering hand tools for better fit; and • Installing hoists and lift tables.	83 percent reduction of back injuries that resulted in lost time.	Not Reported	"An ergo process that runs like a Deere." CTD News (1995) (Ex. 26-1101)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
48	Welding, Vehicle Manufacture	3531	Ergonomic training program implemented, seat height adjustments installed, and work station height adjusted.	Not Reported	Back injury rate went down by 27%.	"Caterpilar, Inc." Welding Journal (1992) (Ex. 26-1066)
49	Chain Saw Assembly	3546	Introduction of new tools and modified production methods, and employee training.	Total sick leave rate dropped from 17 to 13.7 days annually, labor turnover dropped from 35 to 10%, assembly errors reduced by 3 to 6%, total production costs reduced by 10%, and productivity not impacted.	Not Reported	Parenmark et al. (1993) (Ex. 26-1067)
245	Electronics	357	This company determined that much of its injury experience was related to repetitive motion stressors and decided to implement a comprehensive ergonomics program. Their program relied heavily on employee involvement in both analyzing their workstations as well as recommending improvements.	The ergonomics program established by This company in early 1990, not only significantly improved their related injury experience but reduced their workers' compensation costs from $2.6 million in 1991 to $224,000 in 1996.	Not Reported	Business Journal, (September, 1997). (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
124	Computers and Computer Chips	357	A cross-functional team was assembled to benchmark other ergonomic programs both within and outside the semiconductor manufacturing industry. A cross-site team was then assembled to develop a program guideline to provide minimum requirements for the company's site specific ergonomic programs across the country. At each Intel site, local ergonomists have developed written programs that meet these requirements but are tailored to fit their site needs. Implementation is accomplished through the involvement of site safety and ergonomics teams. Standardized training packages have been developed for both office and manufacturing environments and are taught corporate-wide. Internal ergonomic design guidelines have been developed to provide guidance for engineering, facilities and design personnel when designing, installing or evaluating workstations, tools and equipment.	Days away from work for lost workday cases have decreased 72%. Proliferation of the safety culture, which includes the ergonomics program, has resulted in the avoidance of about 20,000 days away from work due to injury during the past four years, and more than $10 million in cost avoidance.	OSHA recordable sprain/strain and cumulative trauma disorder (CTD) rates have decreased an average of 37% for each of the last four years, and are now among the best in the semiconductor industry.	Employee Benefit News, (9/1/99). (Ex: 502-22)
370	Electronic Card Assembly	357	Added new-employee training on lifting postures and changed work practices to require two workers to move a box over 25 pounds. Now every box must have two handles. IBM also redesigned workstations to reduce awkward hand and back movements.	Not Reported	MSDs declined from 32 a year to 17 in 1995. With an average cost of thousands of dollars per MSD case, eliminating 15 per year represents a significant cost saving for IBM.	(Ex. 502-404)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
52	Computer Mainframe Assembly	3571	Training had been provided in proper lifting techniques, general safety and use of special tools. Extensive office workstation ergonomics training was provided. Engineering controls included: • Providing new workbenches to accommodate workers' shorter reaches; • Adding roller-ball conveyor belts and lifting devices to raise the units onto the conveyor belt; • Replacing pneumatic drivers with lighter electric units which had much less vibration and weighed about one pound; • Installing lift platforms that would raise the cabinets 3 feet off the floor; • Providing seated and standing workstations so one employee could build the entire cabinet instead of working on an assembly line in order to reduce the static fatigue; and • Modifying scissor lifts to rise up to 4 feet off the floor.	There are no lost days due to CTDs in the office workplace.	CTD related injuries were eliminated in production.	"AT&T uses cost-conscious program to fight CTDs." CTD News (1995) (Ex. 26-1069)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
50	Computer Manufacturer	3571	The company engaged in several training and education initiatives, including: • Mandated ergonomics training classes for high risk groups; • Created and distributed a 16-page ergonomics brochure; and • Created an "ERGO Hotline" to schedule ergonomics evaluations, report problems, and seek information. Exposure control approaches included: • Limiting manual lifting to 40 pounds or less; educating the employees via a brief program on the basic ergonomics fundamentals; • Purchasing new office sit-stand workstations; • Adjusting the workstation surface height to accommodate each worker; and • Attaching a wider, adjustable keyboard and mouse platform to the standard desk.	Not Reported	• 41 percent drop in reportable upper limb disorders from 1994 to 1995 which addressed about 70 percent of the company's upper-limb reportable injuries. • Further 50 percent decrease in reportable CTD cases from 1995 to 1996. • Reportable cases of CTDs decreased to 25 through November of 1996 compared to 70 cases in 1994.	"Silicon Graphics melds high- and low-tech." CTD News (1997) (Ex. 26-1068)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
123	Computer Manufacturing	3575	An ergonomics program for both the 800 desks and computer-bound office staff and 200 main frame assemblies was introduced. Employees were trained in proper lifting techniques, and special tools like nut drivers were introduced. Pneumatic drivers were replaced by lighter electric units that vibrated less. An awkward conveyor system was replaced by individual scissors-lift platforms. Lifting manipulators were purchased. Office ergonomics training was instituted and ergonomic adjustable office workstations employed. Early reporting to allow improved medical management was encouraged.	Workers' compensation costs, which had been $400,000 in 1990, fell to $8,600 in 1994.	Not Reported	*CTD News* (Ex: 502-22)
53	Copying Machine Control System Assembly	3579	Assembly of the systems was performed on a workbench and required frequent lifting and turning of the part. The bench was replaced by an adjustable stand designed to take the weight of the part being assembled.	Not Reported	MSD rate declined by 50% in the first year. In the second year, the MSD rate declined to one-third.	Oxenburgh (1994) (Ex. 26-1041), Case 37

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
234	Air-conditioning Equipment Manufacturing	3585	The company decided to implement a focused loss-prevention program with a strong emphasis on workplace ergonomics. They analyzed their records to determine where there important risks were. They trained extensively on their new company safety policies and management, safe work practices, accident and injury reporting and unsafe conditions. Since they found that one of the most frequent and expensive shop floor injuries were those caused by highly repetitive motion, they performed a thorough inspection of every aspect of production including each workstation. This revealed that inadequately designed equipment could cause a multitude of cumulative stress injuries. Extensive workstation redesign followed. They also hired a full-time ergonomics professional and provided training on ergonomics to their employees and management.	Two years after starting a focused loss prevention/ergonomics program, this company had reduced their lost workdays by 40 percent and their workers' compensation costs by 43 percent.	Not Reported	Best' Review/Property-Casualty Insurance Edition, (June 1, 1996, p. 70). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
361	Air Compressor Manufacturer	3585	Established teams to address potential ergonomic concerns. Concerns are investigated. Unassisted lifting was limited to a maximum of 20 pounds.	In the 18 months following program inception in June of 1995, lost days by 85%, restricted cases by 50% and first-aid cases by 45%. Union safety grievances which had averaged one every three weeks were completely eliminated.	In the 18 months following program inception in June of 1995, ergonomic-related injuries were reduced by 90%.	(Ex. 502-404)
55	Electronics Manufacture	36	Controls: workstation redesign and job rotation.	Not Reported	CTDs reduced by 46% in one year.	Robinson (1993) (Ex. 26-1102)
157	Electronic Mfg.	36	The ergonomics committee searched for a chair that not only provided comfort but reduced the repetitive motion injuries occurring in manufacturing assembly operations. They purchased seating that provided chair height adjustments, swivel, padding, and waterfall seat design to improve leg circulation.	Not Reported	Recordable injuries declined 28% in the year following purchase of the new chairs.	*Assembly*, (7/1/95). (Ex: 502-22)
54	Hand Tool Operation, Tele-communications Manufacturing	36	Safety and health committee implemented program that included creation of task force, worker training, improvements in workstation design and tooling, and medical management of workers on restricted duty.	Not Reported	Plant-wide incidence of repetitive trauma disorders was 2.2 cases per 200,000 work hours, reduced to 0.53 cases per 200,000 work hours in 1 year after program implementation.	McKenzie et al. (1985) (Ex. 26-1070)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
56	Electrical Equipment Manufacture, Press Operator	36	Automated handling and grinding of resistance elements. Eliminated possibility for hazardous exposures.	Not Reported	Eliminated MSDs	Oxenburgh (1994) (Ex. 26-1041), Case 16
57	Press Operator, Small Electronic Parts Manufacture	36	Press operation caused excessive wrist flexion and palm compression. The press was modified by adding switches that either eliminated hand contact or only involved contact with parts of the hand that do not have nerves close to the skin surface.	Not Reported	29% reduction in musculoskeletal injury incidence.	Oxenburgh (1994) (Ex. 26-1041), Case 42
183	Electronics Design	36	The decision was made to initiate an office ergonomics program. Ergonomically designed chairs were provided to their staff and ergonomic evaluations performed on every workstation of those workers with symptoms. Back cushions, lumbar supports, keyboard/mouse rests and document holders were provided. Frequent short exercise breaks were encouraged. Proper vision correction was investigated. A new-hire office ergonomics training program was brought on line. And regular training in correct posture, exercises, workstation adjustment and back safety is provided.	Not Reported	In 1991, 43% of the company's 250 home office workforce were complaining of pain in their shoulders, back, elbows and fingers. In the past two years they have not had any CTD related complaints. They estimate they are saving 20,000 hours per year in time previously lost to pain, doctors visits and time off. They consider ergonomics to be "proven science."	CTD News, January, 1997 (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
58	Lamp Manufacturing, Materials Handling	3641	Added a vacuum hoist, reduced equipment height, reduced box size and weight, and introduced a back awareness program for employees.	Not Reported	Eliminated back and upper extremity disorders in the last four years.	Carreau and Bessett (1991) (Ex. 26-1071)
289	Telecommunica-tion Equipment Manufacturer	366	Workstations were redesigned to reduce postural stress on workers.	Time loss was reduced over 40% and employee turnover reduced by 75%. A cost benefit analysis showed a return of 9 to 1.	Not Reported	Testimony of Bradley Evanoff, MD, MPH. (Ex. 37-1)
61	Tele-communications Equipment Assembly	3661	Workstation redesign (adjustable tables, illumination), ergonomically designed chairs, and tool redesign.	Musculoskeletal injury sick leave in 1978=5.0, in 1982=2.9.	Not Reported	Westgaard and Aaras (1984) (Ex. 26-1026)
60	Tele-communications Equipment Assembly	3661	Introduced a training program, job hazard analysis, and an engineering program to abate ergonomic hazards. Medical management of injured employees on restricted jobs.	Not Reported	Rate of repetitive trauma disorders dropped from 1.1 per 100,000 hours to 0.26 per 100,000 hours in 1 year.	Pope (1987) (Ex. 26-1073)
59	Telephone Systems Assembly	3661	Implemented an ergonomics program for the assembly line. Elements included an employee awareness program, disorder treatment protocols, job task analyses, job redesign, and cost savings analysis.	Lost-time repetitive strain injuries dropped from 20 to 4 over 1.5 years.	Not Reported	Darcangelo (1989) (Ex. 26-1072)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
118	Electronics Manufacturing	367	Developed a comprehensive ergonomics strategy. Each business unit has a safety committee. The committee conducts hazard assessments by reviewing employee repetitive stress injuries from the past 5 years. The committee then determines which departments have the highest injuries and risks, and are in need of corrective action. Corrective action consists of an initial one hour training session discussing injury types, risk factors, and means of prevention. The training session is followed by the "intervention" process, which identifies alternative means of performing the tasks with the highest injuries. A second method of intervention involves developing an ergonomics specialist team. The team receives additional training including anatomy and pathophysiology. The most frequent interventions/changes have involved keyboard and mouse placement, forearm support and chair use. Exercise may also play a role.	Not Reported	Although increased awareness initially contributed to a rise in reports of repetitive stress injuries, the company's ergonomics program eventually resulted in a significant reduction in the severity of injuries, from the 90th percentile to the 50th percentile.	Richard Cohen, "Ergonomics Program Development: Prevention in the Workplace," *American Industrial Hygiene Association Journal*, 2/97, p. 145. (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
62	Electronics Assembly	367	Job rotation, new assembly line procedures, and ergonomic line balancing.	Not Reported	No new cases of cumulative trauma were reported.	Townes and Imrhan (1991) (Ex. 26-1074)
378	Electronic Circuit Board Assembly Workers	367	Suspended arm support to reduce neck and shoulder muscle static loading.	Not Reported	31 subjects pre-3 months post-shoulder symptoms decreased from 62% to 45%, for neck decreased from 57% to 55%.	(Ex. 26-630)
257	Electronics Manufacturer	367	Implemented an ergonomics program which includes an ergonomics team that determined the objectives; chose hazard-reduction methods and oversaw implementation of the program; reviewed all injuries for those that may be repetitive-strain injuries; inspected the work site to assess job tasks for ergonomic risk factors; completed a worker survey to identify hazards and symptoms that may be related to MSDs and, following collection of this information, prioritized tasks for initiating hazard-control measures. Extensive training was also provided.	While the number of total recordable repetitive strain injuries increased over a 10 year period from 1985 to 1995 (probably due to increased awareness by employees of the work-relatedness of upper extremity pain and encouragement to report injuries), the percentage of repetitive strain injuries with lost workdays dropped from 80-90% to approximately 50%, indicating a reduction in severity of the injury .	Not Reported	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (Cohen, 1997). (Ex:32-339-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
199	Electronic Card Assembly	3672	The company expanded its safety program to include ergonomics. It added new employee training on lifting postures and changed work practices to require two workers to move a box over 25 pounds. Now every box must have two handles. The company also redesigned workstations to reduce awkward hand and back movements.	Not Reported	MSDs declined from 32 a year to 17 in 1995. With an average cost of thousands of dollars per MSD case, eliminating 15 per year represents a significant cost saving for IBM.	IBM Spells Safety; I-S-O," *Occupational Hazards*, December (1995). (Ex: 502-22)
63	Electronics Manufacturing, Various Jobs	3674	Redesigned workstations; introduced powered-screwdrivers; job rotation.	Not Reported	Reduced injuries (not quantified).	Burri and Helander (undated) (Ex. 26-1075)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
213	Electronic Connectors Manufacturing	3678	This facility developed a team of 12 employees from different departments to identify and prioritize problem jobs. The team videotaped the re-reeling jobs and collected information from employees to develop and implement controls. Changes included adding a mechanical arm to maintain the reeling tension; adopting a smaller, lighter reel with slots cut into it for easier handling (or loading older reels only half-way); developing a prototype paper cutoff device to tear the paper; and providing more comfortable chairs and surrounding flat surfaces to encourage better posture and less reaching. Additionally, the facility rotates workers in this department every two hours so they are not reeling the same product all day.	This facility has reduced workers' compensation costs for MSDs from about $73,000 in 1993 to about $28,000 in 1996. During this same time period, the average cost for each MSD claim declined from $6,601 to $2,512.	The site's rate for injuries and illnesses dropped from 12.8 per 100 employees in 1993 to 7.1 in 1996.	Private Sector Ergonomics Programs Yield Positive Results, General Accounting Office, (August 1997), GAO/HEHS-97-163. (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
66	Motor Vehicle Assembly, Various Jobs	371	Introduction of an ergonomics program, including engineering controls, work practice controls, job rotation/job enlargement, medical management, education, and training. Controls implemented included counterbalanced tools, lift tables, and workstation redesign to prevent awkward postures and excessive reaches.	Lost-time workday rate decreased 65%, and the lost-time case rate decreased 48%.	Over a 3 year period, the injury and illness rate decreased 11% and the severity rate decreased 39%.	OSHA Site Visit Case Study No. 10 (Ex. 26-1180)
65	Unpacking Auto Parts	371	A plywood sheet end board had to be removed to unpack crates, requiring excessive force and awkward postures. Plywood sheets were modified to reduce their weight and permit them to slide more easily in the grooves.	Not Reported	Back and shoulder injuries associated with this operation were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 38
64	Vehicle Seat Assembly	371	Ergonomics training was provided. Engineering controls included: • Redesigning seat covers to decrease the number of fasteners by more than 50 percent; • Providing a compression tool to clamp the foam padding to the seat; • Installing adjustable workstations; • Providing electric torque guns. In addition, a program of job rotation was introduced.	Not Reported	Tendinitis cases fell by 93% and carpal tunnel cases fell by 96% in the year following program implementation.	"Problem-solving by committee at General Seating." CTD News (1995) (Ex. 26-1076) (Ex. 32-339-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
318	Automotive Manufacturing	3711	Identified jobs with high-risk factors through medical records, plant surveys and employee complaints. Management and union safety people were trained, employee training developed, ergonomic committees were developed and an ergonomic analysts was put in each plant.	Not Reported	They had a high of 430 CTDs in 1990 which was reduced to 120 CTDs in 1999. A reduction of 72%.	Testimony of William Martin. UAW (TR: 7863-7867)
337	Automotive Assembly	3711	Ergonomics committee came up with a new design for installing a part. New equipment built to raise worker into position instead of worker bending over.	Not Reported	No injuries since the new equipment installed. By 2000, incident rates, were reduced by 50%.	(Ex. 500-12-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
156	Automobile Manufacture	3711	Associates attend a two-hour ergonomics training where they learn how to solve ergonomics problems in their groups. The course explains what causes CTD injuries and what you can do to prevent them. Additionally, in the company's group program, employees nominate a representative who compiles the results of questionnaires about employee comfort and meets with the branch manager, staff engineer, union and safety representatives to discuss ergonomic concerns. This program is activated every time there is an increase in ergonomic concerns.	Not Reported	The first year after training, the company realized a 20% drop in CTDs, followed by an additional 25% drop during the next year.	Kathryn Tyler, "Sit Up Straight," *HR Magazine*, (9/1/98). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
178	Auto Manufacturing	3711	The company designed a plant with assembly lines that would tilt so that employees could work underneath cars without having to bend. It installed an overhead conveyor line designed to move at different heights along the assembly line to provide better access to the part of the car being worked on. In addition, the company instituted a comprehensive ergonomics and medical management program at the plant. Supervisors and employees received training in ergonomics. The company also took the lessons learned from production back to the design groups to incorporate into new models.	Overall, workers' compensation costs have declined and production levels have increased.	Even though ergonomics was considered in the initial design, the process of continuous improvement led to a 40% reduction in work-related musculoskeletal disorders in the trim department.	Ergonomics: The Mazda Way," *Occupational Hazards*, (April 1990). (Ex: 502-22)
154	Auto Assembly	3711	The company designed a special manipulator arm that was suspended from an overhead crane track to install the heavy instrument panels. This design eliminated many of the manual handling activities, repetitive motions and awkward postures. It also improved product quality and increased productivity.	Over a three-year period during which one million instrument panels were installed, the company had no workers' compensation claims reported. Installation of the panels can now be performed by two employees compared with five to six employees using the old method.	Not Reported	*Modern Materials Handling*, (December 1997). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	**Total MSDs**	
270	Automobile Manufacturer	3711	Redesigned tools, fixtures, and work organization in assembly operations.	Reduced long-term upper extremity and back disabilities; CTS surgeries reduced by 50%.	Not Reported	"Summary of Studies on the Effectiveness of Ergonomic Interventions" (June 1995). (Ex. 38-65)
324	Motor Vehicle Assembly	3711	UAW negotiated ergonomics provisions in their national agreement in 1987. Early phases of ergonomic programs identified additional cases of MSDs by encouraging reporting and symptom surveys.	Not Reported	Incidents of CTDs declined from 4% from 1997 and 26% in the last five years.	(Ex: 32-185-3)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
180	Automotive Assembly	3711	The most significant change from the old facility was the design of the assembly line. The line varies in height from one work station to another, preventing excessive reaching, bending and twisting. In addition, the plant installed hundreds of lift devices to aide in the installation of the instrument panel, roof, battery, steering pump, radiator, trailer tow package and spare tire. the plant also uses tilted part bins, shock-absorbing tooling, and a wheeled scooter allowing low tasks to be done while sitting instead of stooping. Finally, the plant employs a 15 member ergonomics committee, and virtually all employees have been through a 1 hour training course on ergonomic risks.	Not Reported	The plant has the lowest cumulative trauma disorder rate of any of the company's assembly plants, 3.03 per 100 workers. The plant also has one of the lowest overall incident rates in the automobile industry, even though the average age of its workforce is 49 years of age.	Gregg LaBar, "Chrysler is Sold on Ergonomics," *Occupational Hazards*, (10/94, p. 209). (Ex: 502-22)
70	Auto Body Assembly, Fixing Side Molding to Body	3711	Replaced pneumatic nut runner with a lighter model. Used a stepped ramp that allowed workers to select an appropriate position relative to the work piece.	Not Reported	Upper-body MSDs were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 50
72	Spray Painting Auto Bodies	3711	Lengthened spray gun trigger to increase gun's grip diameter and allow the trigger to be operated with three fingers.	Not Reported	Cases of hand tendinitis were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 52

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
68	Auto Assembly	3711	Introduced variable height car conveyer belt, articulating arms to move large parts, like dashboards, into place. Also redesigned tools.	Not Reported	50% decline in ergonomic related injuries in the first year. 35% decline in second and third years.	LaBar (1992) (Ex. 26-1053)
67	Truck Manufacturing, Various Jobs	3711	Introduction of company ergonomics program in 1990. Engineering controls: substituted machine riveting for manual riveting, introduced raised work heights, and installed lifting devices. Introduction of job rotation for 85% of the workforce.	Lost-time injuries fell from 80 to 28 in 2 years. Lost workdays fell from 1,402 to 193.	CTD cases fell from 105 to 54 in 2 years.	Mandelker (1993) (Ex. 26-1063)
69	Auto Assembly Line Worker	3711	28 projects were redesigned to change specific jobs, making them ergonomically less troublesome.	Reduced from 3,134 lost days per year to 1,355 lost days per year after project completion.	Not Reported	Brandon (1992)
71	Spot Welding onto Auto Frame	3711	Fixed a large-diameter circular handle to the welding frame, which allowed the frame to be moved into any position while keeping the wrist in a straight posture.	Not Reported	Wrist injuries were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 51

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
206	Truck and Bus Assembly Plant	3713	The company established an ergonomics program using a comprehensive team-oriented approach. To fix problem jobs, the company installed hoists, changed job procedures and modified lifting requirements. Most changes cost nothing. In fact, the company incurred costs for only 10% of the problem jobs it fixed.	The costs associated with work-related musculoskeletal disorders (MSDs) have dropped 14% each year in the three years since the program was implemented. Workers' compensation costs dropped from $1.4 million before the program to $544,000 three years later.	Not Reported	*Business Insurance*, (October 27, 1997). (Ex: 502-22)
73	Auto Instrument Panel Assembly, Manual Handling	3714	Installed a hoist system to remove panels from conveyor and transport them to shipping containers.	Lost-time back injuries associated with this operation were eliminated.	Not reported	Oxenburgh (1994) (Ex. 26-1041), Case 40
77	Automotive Engine Assembly	3714	A hoist was replaced by a conveyer belt set at waist height and part of the assembly process was automated.	70 days lost time and over 1,000 days on restricted duty were reduced to no lost days and no personnel on restricted duties.	Not Reported	Oxenburgh (1994) (Ex. 26-1041), Case 2
80	Auto Instrument Panel Sub-Assembly	3714	Spring clips were pushed into position using a hand tool that required excessive force to operate. New tool was designed to reduce force and awkward positioning of the hand and wrist.	Not Reported	Wrist and hand injuries were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 49
81	Trimming Molding with Hand Cutter	3714	Hand cutters were replaced with automated or air-powered cutters.	Not Reported	Hand and wrist injuries associated with this operation were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 54

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
74	Pneumatic Screw Feeder Operation, Auto Instrument Panel Assembly	3714	Installed a counter-balanced articulated arm to reduce the weight of the tool.	Not Reported	Upper-body MSDs were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 46
76	Manufacturing of Electronic Components, Various Jobs	3714	Introduction of an in-plant ergonomics program, engineering controls including hand tool and workstation redesign, and lift devices. Job rotation and other administrative controls, work practice controls, medical management, and training also implemented.	Decrease of 50% from 116 lost-time days/100 workers (1990) to 58/100 workers (1991) for MSDs. Additional 50% decrease in 1992 to 29 lost-time days/100 workers.	The incidence rate of ergonomic disorders decreased by 67% from 37/100 workers (1990) to 12/100 workers (1992).	OSHA Site Visit Case Study No. 8 (Ex. 26-1178)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
75	Computer Operator	3714	The company instituted a biannual training program to emphasize good lifting and pushing techniques as well as good posture. Also instituted a stretching exercise program and encouraged the CAD operators to take frequent short breaks. Engineering controls included: • Purchasing 27 back cushions, 71 lumbar supports in three different sizes, 24 keyboard/mouse rests, and 12 document holders in the past five years; • Providing adjustable chairs; and • Providing foot rests for shorter workers.	Saved 20,000 hours lost time per year since eliminating CTD-related complaints.	Not Reported	"Communication drives process at Siemens." CTD News, (1997) (Ex. 26-1077)
78	Small Parts Assembly Machine Operation	3714	Jammed machine required operator to climb a bar ladder while carrying a heavy load. A correctly designed ladder and catwalk were installed along with a chute to dispose of damaged parts without the need for carrying them.	Not Reported.	Foot and ankle MSDs associated with the operation were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 47

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
262	Engine and Transmission Assembler	3714	An ergonomic intervention approach was applied to the manual truing of flywheels. Incorporating worker participation, the truing task was chosen for evaluation and intervention based upon the number and severity of injuries associated with this task. Recommendations to modify the task were agreed upon and workers were videotaped while performing the truing.	An 82% reduction in restricted or lost work time.	A 29% decrease in the incidence of total musculoskeletal disorders, an 82% decrease in the severity rate, and a drop of 78% in the incidence of upper extremity disorders.	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (Moore, 1994). (Ex:32-339-1)
79	Automotive Air Conditioner Manufacture, Material Handling	3714	Installed overhead conveyor belt that moves the condenser cores through the various procedures, minimizing manual handling. Also installed box tilers to assist in packaging and scissors lift for stacking.	Prior to program, plant averaged 50 lost-time injuries per year, many of those back injuries. After program implementation, 2 back injuries were recorded over a 4-year period.	Not Reported	LaBar (1991) (Ex. 26-1078)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
184	Automotive Trim Mfg.	3714	The company decided to implement a corporate ergonomics program. Each of their facilities sent one engineer and one safety and health staffer to a three-day applied ergonomics class. Then all employees were given one hour of training in the ergonomics of how to work safely. Their design engineers were given four hours of training in how to design jobs with good ergonomics built in. Many practical workplace changes were made including: using tilt tables; changing to user-friendly tools; using proper lifting techniques; changing to adjustable workstations; optimizing the location of parts bins; using rotating carriers; using assistive lifting devices; and new-hire ergonomics orientation.	Not Reported	By 1998, the company cut their ergonomic-related injuries by 70%.	*C.D.T. News,* (April 1999). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
181	Automotive Piston Mfg.	3714	The company committed to establishing a comprehensive ergonomics program. They started an ergonomics training and education program for their employees and as part of it, stressed the importance of early reporting of pains and symptoms to allow improved early medical management. They analyzed the workstations in their plant and where possible introduced redesigns allowing a greater degree of adjustment. Where redesign was not feasible, they instituted job rotation.	The ergonomics program established by this mid-sized manufacturer in the early 1990's not only improved their related occupational injury experience, but cut their workers' compensation costs by 47% and improved employee morale noticeably.	Not Reported	Human Resource Magazine, (October, 1995). (Ex: 502-22)
325	Motor Vehicle Parts Automotive Stamping	3714	UAW negotiated ergonomics provisions in their national agreement in 1987. Early phases of ergonomic programs identified additional cases of MSDs by encouraging reporting and symptom surveys.	Not Reported	Incidents of CTDs declined from 13% from 1997 and 24% over five years.	(Ex: 32-185-3)
284	Automotive Equipment Manufacturer	3714	An ergonomics program was put in place.	In 6 months, workers' compensation costs went down 87%.	In 6 months, recordable injuries dropped 53%.	Testimony of David C. Alexander. (Ex. 37-7)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
113	Auto Parts Manufacturing	3714	In 1996/1997 the company began implementation of their ergonomics program. Injury and illness data were used to identify incidents and areas where ergonomics related concerns were present. In response to analysis of these incidents, equipment modification has begun, including relocating two hand press controls and adding hoists and other mechanical lifting equipment. A medical management program has been started to identify musculoskeletal disorders before they become severe and provide better treatment for those that do occur.	Since beginning implementation of their ergonomics program in 1996/1997 this mid-sized manufacturer has reduced their lost work-day injuries and illnesses by 50%. The severity of those incidents that are occurring has also been reduced.	Not Reported	OSHA case files (Ex: 502-22)
313	Automotive Products Manufacturer	3714	A participatory ergonomics program with multi-disciplinary representation was implemented.	From 1993 thru 1997, an overall reduction of 42% was achieved in workers' compensation.	From 1993 thru 1997, MSD claims were reduced by 85%.	(Ex. 500-71-57)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
158	RV/MH Door, Window Mfg.	3716	With the aid of a physical therapist, the human resource manager assessed jobs on the production lines and eliminated excessive hand/wrist twists and pinching motions. Tools, originally designed for men, were replaced with smaller ones that better fit the smaller hands of the predominantly female workforce. Management officials introduced safety committees, job rotation and awards programs. They also added employee education and training and a new reporting system to detect work-related musculoskeletal disorders (WMSDs) in the early stages.	Not Reported	In 1994, work-related repetitive motion injuries had dropped by 20 percent, and the company was able to self-insure.	Preventing Repetitive Motion Injuries," *HR Magazine*, (Oct. 1995). (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
82	Manufacture of Jet Aircraft Engine Parts, Various Jobs	372	Implementation of ergonomics program, including engineering control measures, work practice controls, medical management, education, and training. Controls implemented included redesigning workstations to provide employees with more room to perform tasks, adding anti-fatigue mats and adjustable footrests, removing or padding tables and shelves to reduce contact stress, and installing vibration-absorbing pads onto grinding wheels.	Not Reported	Decrease in carpal tunnel syndrome cases from 26 in 1988, 11 of which required surgery, to 1 case in 1992 which did not require surgery.	OSHA Site Visit Case Study No. 9 (Ex. 26-1179)
332	Helicopter Assembly	3721	Three labor management teams formed in areas with highest injuries to determine causes. Teams received training and bring problems to the attention of management. Management must respond in 2 weeks. Budget in place for recommended engineering changes.	Lost work day and severity rates have dropped 75%. Worker compensation costs have dramatically improved. Production time decreased by 33% in areas where changes implemented.	The total OSHA recordable incidence rate dropped by 25% in one year alone.	(Ex: 32-339-1-1)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
224	Aircraft Manufacturing	3721	Starting in 1993, The company started a major effort to educate, train and encourage their workforce to "move smart." They made the design of manufacturing tools and related manufacturing processes a top concern. Their approach to education and prevention has been multi-pronged. They have a goal of training a member of each organizational unit in ergonomic evaluation and problem-solving. This enables routine ergonomic evaluations to be performed locally and complex problems to be referred to their professional ergonomic staff.	Not Reported	Since 1993 ergonomic-related injuries have dropped by a third.	The Everett Washington Herald (7/12/99). (Ex: 502-22)
379	Sheet Metal Mechanics	3721	Comprehensive program of education, job placement, job modifications and medical management designed for employees based on individualized risk assessments.	Increased total recordable case incident rate and hours worked per employee. Decreased total lost-time case incident rate, lost-time severity rate, and workers' compensation costs per employee. Benefits to cost ratio of 16.5/1.0.	Not Reported	(Ex. 38-131)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
328	Avionics and Commercial Aircraft Manufacturer	3721	Program consisted of management commitment and employee involvement. Program elements such as work-site analysis, hazard prevention and control, medical management and training and education.	Normalizing the lost-work-days per average headcount shows a decrease from 6.28 lost workdays per person in 1992 to 1.59 in 1995 (25.3%).	Musculoskeletal and cumulative trauma disorders dropped from 79% of reported cases in 1989 to 44% in 1995.	(Ex: 32-339-1-76)
170	Aircraft Engine Component Manufacturer	3724	This employer implemented their ergonomics program by emphasizing their employee training program and implementing a program of process improvement to remove or reduce stresses responsible for soft tissue injuries from their assembly lines.	Within three years of joining the Maine 200 Pilot program and strengthening ergonomic training and process improvement efforts, this employer had by 1996 reduced their lost time injuries from a previous high of 112 to 10, and their workers' compensation from a high of $280,00 to $54,000.	Not Reported	OSHA case files (Ex: 502-22)
249	Aircraft Parts Manufacturing	3728	Boeing founded its ergonomics program on OSHA's "Ergonomics Program Management Guidelines for Meatpacking Plants." Over the course of two years, Boeing spent approximately $800,000 towards improving the condition of furniture, lighting and tooling.	In 1995, lost workdays dropped to 1,651. By 1996, the number dropped to 600 days.	By 1995, the injury rate had dropped to 3.8 per 200,000 man hours. Finally, MSDs accounted for only 44% of recorded injuries in 1995.	Lance S. Perry, "Step-by-Step Planning: The Ergonomics Lessons Learned at Boeing Offer Insight for Assemblers Putting Together Their Own Programs," *Assembly,* (3/1/97). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
83	Shipbuilder	3731	Initiated training classes covering the nature of CTDs, anthropometry, work physiology, back and wrist anatomy and proper work techniques. In-depth training course covered tool selection, work habits, alternating trigger fingers and hands. Workers participated in evaluating and developing interventions for the welding department, and selecting pistol grip and in-line based tools so as to keep the wrists in a neutral posture. Installed scaffolding at the right height and distance from the work, and used ladders or installed scaffolding to higher positions for the work above shoulder height.	Decreased to only 6 lost-time ergonomics wrist injuries through November 1996, since training completed in June 1995. Eliminated lost time back injuries since July 1995.	Eliminated wrist injury in the welding department until March 1996. Reduced ergonomics case rates about 30 percent during 1996.	Training a 'limbsaver' at Newport News." CTD News (1997) (Ex. 26-1079)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
223	Shipbuilding	3731	The company decided to establish a formal ergonomics program. Injury and illness records were analyzed to identify high risk departments for priority intervention. These jobs were evaluated and interventions identified. In-depth employee training on tool selection, work habits and mechanical equipment utilization was begun. Ergonomically stressful welding operations were replaced by improved processes. Material handling and scaffolding use were analyzed, improved techniques identified and introduced with additional training.	Two years after establishing a broad based ergonomics program the company's lost-time ergonomic case rate fell 55% and they realized savings of $1.4 million in workers' compensation costs.	In two years following the establishment of their ergonomic program their ergonomic case rate fell 30%.	CTD News,(January, 1997). (Ex: 502-22)
84	Motorcycle Manufacturing, Flywheel Milling Operations	3751	Introduction of lighter flywheel castings and an overhead lift; introduction of a customized deburring machine eliminating vibration exposures; introduction of a customized 40-ton press eliminating the use of the brass hammer.	MSDs involving lost or restricted workdays dropped from 27.6 per 100 workers in 1989 to 12.5 per 100 workers in 1993. The severity rate of MSDs dropped from 610 lost or restricted workdays per 100 workers in 1989 to 190 days per 100 workers in 1993.	Not Reported	McGlothlin and Baron (1991) (Ex. 26-1080)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
85	Assembly of Pressure-sensing Instruments	3823	Forceful turning actions were required to fit an O-ring in place. Cordless screwdrivers were used with a custom attachment to bring wrists into stronger position and allow hand to employ a power grip.	Not Reported	Wrist and arm MSDs were eliminated.	Oxenburgh (1994) (Ex. 26-1041), Case 44
179	Medical Equipment	384	The company hired an industrial ergonomist and simultaneously began a formal safety program. Ergonomic awareness became a visible part of the company's daily decision making process. 3M redesigned workstations, adding adjustable chairs, repositioned computer keyboards and relocated video terminals.	Not Reported	One of the company's departments experienced a 64% drop in its injury and illness rate following adoption of the company's ergonomics program. Injuries and illnesses declined from 5.4 to 1.61 incidents per 200,000 hours worked. Ergonomic changes played a significant role in the improvement.	3M pilots ergonomic program to reduce OSHA recordables," *CTD News*(1995). (Ex: 502-22)
277	Medical Device Assembly Plant	380	Redesigned workstations to reduce reach distances, provided adjustable chairs and foot rests, provided fixtures and pneumatic gripper to eliminate pinch grips.	Plant-wide severity rate reduced from 154.9 to 67.8 lost time days per 200,000 worker hours.	Plant wide CTD incidence rate reduced from 13.7 to 11.3 per 200,000 worker hours after intervention.	"Summary of Studies on the Effectiveness of Ergonomic Interventions" (June 1995). (Ex. 38-65)
309	Medical Device Production	384	Ergonomic interventions included new work stations, assembly fixtures, and ergonomic training of employees to improve manual assembly methods.	There were 321 lost work days and since new program there has been no additional lost-work-days.	Since the program there have been no new CTD's. They were reduced from 14 to 0.	(Ex. 500-114)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
86	Medical Needle Manufacture, Inspection Station	384	Used task forces to identify jobs involving worker exposures to risk factors. Identified problems on quality control line and implemented design changes to the workstations.	Not Reported	Achieved 75% reduction in upper extremity MSD cases	Benden (1994) (Ex. 26-1081)
87	Manufacture of Suction Canisters Used in Surgical Procedures	3841	Introduction of an ergonomics program utilizing a medical management program, employee training program, job rotation, and engineering controls. Controls implemented include replacing old wooden supply stations with ergonomically designed stations, and automating various processes.	Not Reported	Decrease in the ergonomic injury rate from 5.2/100 workers (1989) to 2.8/100 workers (1993).	OSHA Site Visit No. 16 (Ex. 26-1183)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
130	Manufacturing Kidney Dialysis Machines	3845	The company organized an ergonomic task force consisting of employees from its engineering and manufacturing departments. The task force determined that three areas needed attention: workstations, tools and training. They selected new workstations to alleviate problems associated with reaching and bending. The new workstation allows parts to be placed in bins on articulating arms that workers can pull toward them as needed, also eliminating unnecessary reaching. They replaced all hand tools and conducted extensive training on the proper ways to use the new equipment.	A videotape analysis revealed that the new workstations required 61% fewer reaches than the old models. Since installing new workstations, the company has recorded a 85% reduction in lost workdays from 1990 to 1993. Because the new workstations reduce the number of movements and amount of time needed to assemble the machines, productivity has also increased.	Not Reported	"Ergonomic Initiative Reduces Worker Claims," *Assembly,* (9/1/94). (Ex: 502-22)
88	Manual Handling of Bulk Paper	386	Two operators manually lifted large wads of paper from a trolley. Manual lifting was eliminated by installing a scissors lift. In addition, the trolley's runners were replaced by roller bearings that enabled the paper to be loaded onto the scissors lift without manual lifting.	Not Reported	There were 18 back injuries in one year prior to implementing changes. There have been no back injuries in the 3 years since modifications were made.	Oxenburgh (1994) (Ex. 26-1041), Case 36

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
357	Flatware and Hollow-ware Silver Manufacturer	3914	Reduced manual handling and awkward postures present in affected jobs. Purchased lifts to eliminate manual handling, installed a chute to eliminate the need for employees to carry heavy bags, and designed an inclined adjustable support to reduce awkward neck and shoulder postures.	Total lost workdays have dropped from more than 300 in 1992 to 72. Total workers' compensation dollars for the company dropped from $192,500 in 1992 to $27,100.	Back injuries declined from 7 to 2 (71%).	(Ex. 502-404)
89	Manufacturing Board Games, Inspection and Packing	3944	Job analysis and problem solving involving employees to redesign packing workstations. Design changes included raising the height of conveyors, slowing conveyor speed (no effect on throughput), placing roller conveyors on an incline to facilitate carton removal, and changes in work procedures.	Not Reported	Eliminated all cumulative trauma injuries associated with job.	Cook and Marcotte (1990) (Ex. 26-1082)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
111	Fitness Equipment Manufacturer	3949	The company formed a committee to brainstorm on ways to reduce work-related musculoskeletal disorders (MSDs). The company purchased adjustable workstations and began rotating jobs. They adopted a new clamp that reduced both the number of times that the clamp was opened and closed and the force needed to operate it. The company provided time during the day for stretching and flexibility exercises.	Not Reported	In the three years since the program was implemented, there has been only one case of carpal tunnel syndrome in the racket stringing department. The case was detected early through medical management and was treated without surgery. The ergonomics program also increased employee morale.	*Professional Safety,* May 1987 (Ex: 502-22)
251	Feather Duster Manufacturing	3991	In 1998, the company established an ergonomics program. Winding machines, used to rotate duster handles while lambs wool or feathers were attached, were redesigned to remove an upper extremity stressor. Employees were trained on wrist relaxation exercises and encouraged to take frequent exercise breaks.	Since 1998, they have cut lost work days by more than 95%.	By instituting an ergonomics program in 1998, this small feather duster manufacturer was able to cut their rate of ergonomic-related injuries by 80%.	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
90	Railroad Repairmen	40	Introduced storage of tools and materials off the ground between knee and shoulder height; devised winches to lift and handle heavy equipment; and redesigned work tables, dollies, and carts to more easily handle train car parts.	Lost-work days reduced to zero for back injuries.	Low-back injuries reduced to zero.	McMahan (1991) (Ex. 26-1083)
246	Railroad Car Maintenance and Repair	4011	This railroad asked the Safety Research Division of the Association of American Railroads to train its safety professionals to conduct ergonomic evaluations for manual material handling. To analyze tasks in the repair shop, the railroad involved its safety professionals, line managers and employees. Then, jobs were redesigned to reduce the risk of back injuries. Today tools and materials are stored off the ground between knee and shoulder height. Employees now use winches and carts or dollies to lift heavy equipment.	The company estimated a benefit/cost ratio of 10 to one for the changes. Productivity increased by more than 67% with no change in staff size. Low-back injuries and the associated lost workdays were eliminated, and absenteeism dropped to 1%.	Not Reported	Fitting work to workers," Railway Age, (August 1991). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
335	School Bus Drivers	4151	They identified flaws in bus designs and came up with 9 specific areas needing improvement. New buses have ergonomic seats with many adjustments and support areas, power assisted doors and tilt steering wheels.	Worker compensation claims in the last five years have dropped by a third.	Not Reported	(Ex: 500-10-1)
91	VDT Operator, Package Delivery Service	42	Introduced sit-stand workstations that permit workers to adjust workstation to meet specific needs.	Not Reported	Reduced MSD cases by half in 12 months.	Nerhood and Thompson (1994) (Ex. 26-1084)
92	Freight Truck Terminal Operations	4213	Established ergonomics program in response to rising number of back injuries. Program elements include analysis of injury records to identify hazardous operations, extensive use of lifting and carrying devices, providing extra personnel to handle heavy or awkward freight, employee training, and medical management of injured workers.	There were 7 lost-time injuries in 1989, followed by 4 in 1990 and 5 in 1991.	Total number of MSD cases declined from 13 in 1989 to 7 in 1990.	OSHA Site Visit No. 5 (Ex. 26-1177)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
239	Telephone Utility	481	Since 1995 this facility has completed several weeks of training seminars aimed at office ergonomics. They have also performed ergonomic workstation evaluations to identify repetitive motion stressors that are present in their workplaces. Some upgrading of workstations has occurred, such as the installation of larger monitors. More upgrading remains to be done, including making their workstations more adjustable.	In the two years since starting their program in 1996, the number of associated lost work-days has been cut by 75%.	In the two years since starting their program in 1996, their rate of ergonomics-related cumulative trauma injuries has been cut by a third.	OSHA case files (Ex: 502-22)
93	VDT Operation, Tele-communications Establishment	481	Retrospective study of the impacts of an ergonomics program on 500 VDT operators. Program included job task analyses, workstation redesign, and worker education and training.	Not Reported	Number of upper extremity disorders over the 6 months prior to implementation of the program was 49; this was reduced to 24 for the 6 months following intervention.	Tadano (1990) (Ex. 26-1337
122	Telecommunica-tions	481	This company developed an $18 million ergonomics program, providing education, training, brochures, and interfocal eyeglasses for video terminal operators.	Workers' compensation claims were reduced by 33%.	Not Reported	Joanne Wojcik, "Ergonomics Proves Worth," *Business Insurance*,(11/1/93) (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
258	Nuclear Power Plant	4911	Initiated an ergonomics program in 1995 in response to a growing number of repetitive motion injuries among computer users found on their OSHA 200 log. Interventions, in the form of ergonomically designed furniture, were installed and then evaluated for effectiveness in follow-up visits. Education and training were also provided.	Not Reported	Within weeks, 9 of 27 employees in the pilot program had their symptoms disappear altogether, while 6 additional employees said they experienced significant improvement. Following the success of the pilot program, the employer implemented the program for the entire workforce. Of 81 cases with medical symptoms, 97% of all employees had their symptoms disappear, improve significantly, or show some improvement following the introduction of ergonomic furniture. In 1996, the employer had no recorded OSHA 200 log work-related injuries for the first time in their history.	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (Fernberg, 1997). (Ex:32-339-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
94	Materials Handling, Electrical Utility	4911	Redesigned equipment: • Weight of the water coolers reduced from 10 lbs to 5 lbs. • Rotating platform for transformers. • Step and grab handles added to trucks. • New shovel handle and new pry bars. • Position of the kegs on trucks was lowered to minimize twisting of the back.	Lost time injuries reduced to 0.42 per 100 employees in 1989.	Injuries due to getting in and out of trucks reduced from 9 to 0 in year following redesign. No injuries from lifting the water kegs since the changes.	"Foiling field injuries with ergonomics." Electrical World (1990) (Ex. 26-1085)
387	Electric Utility's Warehouse System	4911	Four methods were used to evaluate the risk of exposure to injury before or after ergonomics intervention: the 1991 NIOSH lifting equation, the Static Strength Prediction Program, the Lumbar Motion Monitor, and the Borg psychophysical assessment of effort.		Results from applying the four methods to the re-engineered tasks showed that the probability of low-back disorder factors was reduced by as much as 29%, the percentage of people capable of performing tasks was increased by as much as 90%, the NIOSH Lifting Index was reduced from above 2.0 to less than 2.0, and the psychophysical assessment of effort was consistently reduced from the "heavy or strong" to the "light or moderate" range.	(Ex. 500-41-93)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
354	Electric Utility	4911	This company establish an ergonomics program focusing on the prevention of back injuries. They established a training program including such basics as how to ensure you get into the best possible position and how to carry, set up and take down a ladder safely. Back biomechanics proper lifting techniques are also covered and are reemphasized repeatedly.	Not Reported	Since starting their ergonomics program, focused on back injury reduction and using a back-to-basics approach, the company has reduced their incidence rate by 25%.	(Ex. 502-404)
95	Data Entry Operator, Gas and Electric Utility	4932	• Engineering controls: workstation design. • Administrative controls implemented.	Lost time due to work-related injuries decreased from 1,008 hours/month to 584 hours one year later.	Not Reported	Couch (1990) (Ex. 26-1086)
282	Waste Management	495	Program includes analysis of occupational accidents, revision of the safety procedures manual, participatory training classes, improving and evaluating working procedures and personal protective equipment, etc..	Not Reported	The number of compensated low-back pain cases has been reduced from 330 in 1986 to 87 in 1994, a 73% reduction.	"A Follow-Up Study of Preventive Effects on Low Back Pain at Work sites by Providing a Participatory Occupational Safety and Health Program". (Ex. 500-71-60)
96	Sewing Machine Operator	5137	Installed padded, swivel chairs with adjustable backs and improved materials handling methods. Also instituted an exercise program.	Not Reported	Incidence rate of tendinitis decreased from 12% to less than 1% in some plants.	Hammond-Smith (1990) (Ex. 26-1087)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
97	Material Handling, Grocery Distribution Center	514	Implemented comprehensive program that included hazard identification and job hazard analysis, medical management and reassignment of injured employees, worker training, and implementation of engineering and work practice controls. Controls included making minor modifications to some forklift equipment, replacing other equipment, and providing ergonomically designed workstations for data entry personnel.	Not Reported	Number of MSD workers' compensation claims declined from 14 in 1989 to 8 in 1991.	OSHA Site Visit No. 4 (Ex. 26-1176)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
248	Food Service Distributor	514	The company formalized its ergonomics program under the leadership of its occupational health nurse. The company started by instituting an early return to work plan. Workers were encouraged to report any symptoms. The company re-racked its warehouse and put brakes on the hand trucks. The company assessed its customers' locations for hazards during delivery and worked with its customers on improvements. The company also worked with its suppliers to get smaller bags, handles on packages, sturdier cardboard and lighter boxes.	Just one year after implementing its ergonomics program, and the cost of workers' compensation cases was down by more than 45 percent. For the first eight months of the company's fiscal year 1999, total costs were down to about a quarter of the 1996 total.	Just one year after implementing its ergonomics program, the company's injuries and illnesses had dropped 25 percent. For the first eight months of the company's fiscal year 1999, major back injuries have dropped from 76 to 21.	Presentation at the Applied Ergonomics Conference, Houston, (March 1999). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
380	Large Commercial Nurseries	5193	The team selected for intervention specific high risk jobs involving the manual handling of plants in 1 and 5 gallon plastic containers. A set of handles for carrying and moving plants was developed. In focusing on manual materials handling, they looked for opportunities to do things which would have a positive effect on risk factors for WRMSDs and the modifiers used to calculate the revised NIOSH lifting equation. These were: 1. improve coupling (grip), changing it from a pinch to a power grip if possible. 2. reduce moments by getting the load closer when lifting and carrying. 3. improve trunk and upper extremity posture. 4. Reduce the speed &/or acceleration of lifting movements 5. reduce the amount of force require	Not Reported	All measures indicate large-magnitude reductions in targeted risk factor exposures, including extreme stooped postures, repetitive finger pinch grip, and repetitive lifting and lowering of containers.	(Ex. 500-26)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
207	Lumberyard	5211	The site began to formalize and improve their overall safety program by documenting their program's operation and policy in a manual. Their ergonomics program was separated out and strengthened in 1995. They invited an ergonomist from Ohio State Workers' Compensation program to survey their site and used his recommendations to improve their program. They use ergonomic checklists to have each of their employees evaluate the ergonomic appropriateness of their personal protective equipment, mechanical equipment and workplace. They completely redesigned their office workstations in 1994.	In early 1997 they were awarded OSHA's VPP STAR status. They have not had any lost time injuries since starting their VPP application process.	Not Reported	Linda Hill, Weyerhaeuser Customer Service Center, Safety Program Administrator, phone call (7/15/99). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
131	Retail Sales	53	The company established ergonomics as part of their overall health and safety program. An active case management program was established to aggressively manage existing claims. Detailed workplace risk assessments were performed, focusing on material handling and repetitive motion risk factors. Job redesign and rotation were introduced as well as on-the-job exercises. Additional mechanical handling equipment was purchased. Training sessions on proper ergonomic lifting techniques were conducted.	Not Reported	From 1992 to 1997, ARC recorded a 60% drop in CTD-related claims, an 86% drop in total incurred losses from all injury cases and a 79% drop in the average cost per claim.	*CTD News*,(January, 1998) (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
247	Catalog Distribution Center	5311	The company implemented an ergonomics program. The program included four basic elements: ergonomics training, work-site analysis, medical management and a formal communication process. The company identified 22 activities associated with MSDs, which affected about 75 percent of the workforce. The company developed an alternate duty plan to get injured workers back to their jobs more quickly and installed an ergonomics hotline to enable employees to make suggestions immediately.	Not Reported	The company injury and illness incidence rate dropped from 12 in 1992 to 6 in 1995–a 50% reduction. The company completely recouped the cost of the ergonomics program in three years and is now saving about $500,000 per year as a result of the program.	Presentation at the Ergonomics: Effective Workplace and Best Practices Conference, Chicago (1997), NIOSH proceedings. (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
351	Retail Grocery	5411	An ergonomics committee was formed to address MSD problems. They purchased adjustable work tables, semi-automatic wrapping machines, and a re-designed meat cutting knife. Purchased vertical scanners for the checkout counters and trained employees.	Not Reported	They had reduced MSD claims from 47 in 1991 to 26 in 1992.	(Ex. 502-404)
225	Grocery Stores	5411	The company implemented an ergonomic program in 1987. The company analyzed and modified the check stands. For about $500 per stand, the company raised work heights, purchased checker fatigue mats, lowered produce scales, raised keyboards and placed them on adjustable pedestals, and made the grocery bag wells adjustable to accommodate varying checker heights. An ergonomist met with employees several times to train them on ergonomics and demonstrate how to adjust the new equipment.	Not Reported	In eight years following implementation of the ergonomics program, only two workers have developed confirmed cases of MSDs. Since 1990, the company has reduced its experience rating (a Washington State Dept. of Labor & Industries formula involving incidence rate, medical claims, and time loss claims) by almost 43%.	Food retailer rewrites user, safety manuals for safer workplace," *CTD News*, (1995). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
364	Retail Grocery	5411	Modified its checkout stations and scanners to reduce lifting and twisting motions. Medical management program ensured immediate care and treatment. Training on causes and symptoms of work related MSDs and on good work practices.	Not Reported	Over a 4-year period, workers' compensation claims for MSDs dropped from 21 to 5.	(Ex. 502-404)
98	Restaurant Worker	5812	Reduced the amount of food served by the workers, and heavy porcelain crockery replaced with plastic.	Not Reported	Reported injuries decreased 40%.	Oxenburgh (1994) (Ex. 26-1041), Case 17
99	Clothing Store	5932	Staples were reduced to one per tag and job rotation was introduced so that no one person stapled for more than 45 minutes at a time.	Not Reported	In 1994-1995, 23% of pricers had CTDs; 2 had bilateral carpal tunnel releases and were unable to return to work. In 1996-1997, 10% of pricers were affected, but all have returned to their jobs without surgery or impairment.	"ARC takes thrifty approach to ergonomics." CTD News (1998) (Ex. 26-1089)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
177	Banking	60	The facility initiated their ergonomics program by evaluating their injury and illness experience to identify when, where and how incidents were occurring. They also surveyed their employees to identify what they did and did not like about their current workstations. Using these results workstations were redesigned to reduce the stressors associated with data entry. Their process relied heavily on worker involvement and management responsiveness to focus their efforts on reducing workplace injuries.	An ergonomics program focused on office soft tissue injuries enabled this Maine 200 Pilot program participant to cut both their ergonomic related injuries and workers' compensation costs by 50% in three years.	Not Reported	OSHA case files (Ex: 502-22)
100	Data Entry	6021	Adjusted workstations and lighting.	Not Reported	Reduced neck tension syndrome from 54% to 16%.	Luopajarvi et al. (Undated) (Ex. 26-1090)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
250	Insurance and Financial Services	63	The company began developing its own ergonomics program in the early 1990s. As part of the program, the company implemented "software usability labs" that "engineer out" any key combinations that put the hands in an awkward position. The company also designed its own work tools when it found no commercial products were adequate. For example, the company designed a large-handled staple puller when it found that standard pitch-type removers were causing discomfort, the company also designed a special workstation for a woman with painful back pain and carpal tunnel syndrome. The workstation included a desk that can be used while sitting or standing and a redesigned keyboard. Additionally, the company has conducted over 7,200 one-on-one ergonomics consultations with workers, trained most of its 20,000 workers, and made over 38,000 adjustments to workstations.	After an expected initial increase in reported injuries, the company saw a sharp decline in cumulative trauma disorders. Ergonomics injuries made up 66% of workers' compensation claims in 1992, but only 48% of all of compensation claims in 1997.	Not Reported	Michael Bradford, "This company was Honored for Excellence in Ergonomics: Program Prevents Injuries, Decreases Workers' Comp Costs, Improves Morale," *Business Insurance,* (10/26/98). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
355	Insurance Carrier	63	Established a three-pronged intervention process: 1) Created a corporate infrastructure with the expertise to respond to ergonomic success in workstation design and technologies. 2) Departmental evaluations. 3) Post-injury management process.	In the first year of their program the costs-per-claim of computer-related disorders fell 30%. In the first year of their program surgery rates for computer-related injuries fell 90%.	Not Reported	(Ex. 502-404)
350	Insurance and Financial Services	63	In 1986, the company revitalized its two main headquarters facilities to accommodate ergonomic concerns. The company redesigned workstations. Workers now have indirect, overhead lighting and glare-filtering window shades, adjustable ergonomic chairs, acoustical panels and increased space.	The company's productivity increased 64%. Absenteeism decreased 14%, and the company's worker turnover rate decreased 86%.	Not Reported	(Ex. 502-404)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
163	Insurance	63	Since 1989, the company has implemented the following changes: *Purchasing 900 "ergonomically correct" chairs at the end of 1990 in an attempt to ease low back pain and carpal tunnel syndrome. *Using "lower cost" accessories, such as glare screens, articulating keyboards, and document holders. *Initiating educational programs and training for supervisors and management. *Since 1993, providing ergonomically-designed workstations and indirect lighting in the company's new buildings. *Remodeling older buildings with ergonomically correct office equipment. *Hiring two full-time corporate nurses. In 1993, the nurses helped create an on-site electronic job-site questionnaire requesting information on employee comfort.	The company realized an 80% drop in CTD-related compensation costs from 1992 to 1995. Specifically, CTD-related claims and costs have fallen from 103 and $526,000 in 1991 to 21 and $25,000 in 1995, respectively.	Not Reported	*CTD News*, (4/96, p. 7). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
173	Disability and Life Insurance	6311	They established a comprehensive program addressing office ergonomic concerns. Their first emphasis is engineering the problem out of the workplace. They apply ergonomic principles at the time of purchase to all office upgrades and additions. They are aggressive in individualizing workstations to each employee. Employees are measured anthropometrically to maximize the fit and trained at the time of hire and yearly thereafter. Workplace employee safety and health teams are used.	Their lost workday case rate is 0.3 per 100 employees compared to an insurance industry average of 0.8. Their average lost time claim cost (ergonomic) is under $1,000 compared to an industry average of $19,000.	Not Reported	Lynn Pontius-Gaudette, Head of Safety, UNUM Provident (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
226	Indoor Arena	7349	The arena hired a team of ergonomists, who observed, filmed and analyzed the changeover process. Eventually, existing equipment was used in a different way, and forklifts, floor jacks and stacking dollies eliminated heavy lifting. The ergonomists developed a "drill" for moving the basketball floor using two different forklifts and two different crews on one section of floor. Previously, the process involved simply hoisting each section onto a forklift. The new method eliminated 90 % of heavy-lifting tasks. In order to refine the process even further, one employee invented a new tool (the Harvey bar), which allowed the changeover to be performed not only more safely, but also more quickly.	*$399,825 saved in workers' compensation funds *458 fewer workdays lost *$200,000 improvement in net profit (revenue of arena's operations) *Lowered absenteeism *Injured worker recovery	*39 fewer injuries (claims filed) *50-60 % improvement in worker performance *50-55 % improvement in productivity *100 % improvement in morale	Ian Chong, "An Ergonomics Boost for the Tacoma Dome," *Occupational Safety & Health*, (2/97, p. 56). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
203	Computer/data Systems	737	The company commissioned an ergonomic study to evaluate the work environment in the data-entry department. Based on the results of that study, the company modified existing workstations to reduce the risk of injury. The company installed adjustable equipment and accessories to accommodate the company's multiple users and the various work shifts.	Over a two-year period, the company decreased the amount of their workers' compensation costs from $854 per employee to $17 per worker in data entry.	Not Reported	*Continental Airline Magazine*, March 1999 (Ex: 502-22)
353	Health Care	80	Purchased mechanical lifts and other assistive devices including gait belts. Employees required to use devices and attend training sessions on body mechanics.	Lost workday injuries dropped from 4 per month to only 4 per year in the first unit to use the devices. Throughout the hospital, lost workdays resulting from patient transfer injuries dropped from 15.9 to 13.1 days in 6 months.	Not Reported	(Ex. 502-404)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
218	Nursing Care	805	Starting in 1997 this facility initiated an ergonomics program addressing the hazards associated with the transfers of residents. This program included the formation of a safety committee, the purchase of improved mechanical lifting equipment, training on safe bio-mechanical lifting techniques as applied to patient transfers, the re-emphasis of teamwork between management and staff, and a strengthened program of workplace oversight to ensure good implementation of these changes.	The rate of lost work-days associated with injuries has been reduced by more than half.	Since 1996 their practical ergonomics program addressing resident lifting hazards has cut their rate of related injuries by two thirds.	OSHA case files (Ex: 502-22)
216	Nursing Care	805	This facility has addressed their industry's recognized ergonomics concerns by establishing and enforcing a mandatory no single person lift policy. They have supported this program by purchasing and requiring the use of mechanical lift assists on all resident transfers.	From 1996 to 1998 the applied ergonomics program in place at this small employers establishment cut the number of ergonomic-related injuries and the lost workdays associated with them by 80%.	From 1996 to 1998 the applied ergonomics program in place at this small employers establishment cut the number of ergonomic-related injuries and the lost workdays associated with them by 80%.	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
176	Medical and Nursing Home Care	805	This facility brought several lifts into the facility for a trial period, encouraging employees to test them and provide feedback on the lifts they preferred. The company selected two types of lifts–one to bring residents from a sitting position to a standing position; and one to help residents who are unable to sit up by themselves. The facility purchased 15 lifts–one for every department and a spare to help ensure availability. The facility offers all CNAs training in ergonomics and in how to use the lift assists.	The facility reduced its workers' compensation costs for work-related musculoskeletal disorders by about 30% between 1994 and 1996. Costs dropped from $100,000 to about $70,000.	Incidence rate fell from 14.7 in 1993 to 12.3 in 1996. Employees are pleased with the new lifting equipment that the company is now buying additional lift assists for use in other areas.	Private Sector Ergonomics Programs Yield Positive Results, General Accounting Office, August, GAO/HEHS-97-163 (Ex: 502-22)
217	Nursing Care	805	The ergonomics program being implemented by this facility addresses safe lifting techniques as applied to transfers involving residents.	Not Reported	In the two years since establishing their practical ergonomics program (1996) which stresses safe bio-mechanical lifting techniques for resident transfers, this facility has cut their rate of related injuries in half and the severity of these injuries (as measured by lost workdays) by 40%.	OSHA case studies (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
209	Nursing Care	805	A management change at this center was followed by renewed emphasis on the ergonomic hazards associated with assisting patients with restricted mobility. This included training on proper lifting techniques, and use of mechanical lift assists both to improve patient security during these lifts as well as to reduce ergonomic stresses experienced by the staff certified nursing aides. An adequate number of lifting assist devices were obtained for the facility's staff and residents.	The lost work day injury rate at the center, which had averaged 8.3% from 1996 through 1998, fell to 2.4% after these changes were made.	Upper extremity musculoskeletal disorders, which had averaged 7.1% over this same time, fell to less than 1% in 1999.	OSHA case files (Ex: 502-22)
283	Nursing Home	805	The program included an ergonomic evaluation of patient handling, pilot testing and purchase of new equipment, a train-the-trainer program, and training of 347 nurses and other patient handling staff.	Not Reported	Over the course of the program (one year), the number of back injuries was 30% below the average of the prior three years, with the number of reported injuries in the final quarter approximately 1/7 of that for the three prior quarters.	"Short-Term Efficacy of Back Injury Intervention Project for Patient Care Providers at One Hospital". (Ex. 500-71-61)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
295	Health Care Facility	805	Introduce new lifting devices.	Not Reported	During 1991 and first 9 months of 1992, experienced 8 workers' compensation cases related to strains or sprains. Since new lifts (6 months) only 2 new cases reported, neither of which involved lost time or workers' compensation.	Testimony of Guy Fragala, PhD., PE, CSP. (Ex. 37-4)
175	Nursing Home	805	At the request of management a committee of nurses aides was formed to determine the cause and identify a solution for this concern. The solution that was decided on was to institute an ergonomics lifting program aimed at patient transfers. Mechanical lifting devices were investigated, tried, selected and put into use. Training on the proper use of the new lifts and on proper lifting bio-mechanics was provided. A policy of limiting unassisted lifts to 50 pounds was established.	Two years after starting their program, lost workday cases due to back injuries had been reduced by 80% and associated lost workdays by more than 90%.	Not Reported	Wall Street Journal, (March 20, 1995). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
166	Nursing Care	805	The company established an ergonomics program addressing the lifting hazards associated with patient transfers. They established two safety committees, one to address changes in the physical plant and the other to focus on reducing injuries and illnesses. They changed their adjustable beds from mechanical hand crank units to electric powered ones to reduce ergonomic stresses affecting their staff's backs. They added powered lifts to their facilities to ease the stresses associated with patient transfers.	Not Reported	Three years after being invited to join the Maine 200 Pilot Program this nursing care employer's ergonomics and safe lifting program had reduced their total occupational injuries and illnesses by 40%.	OSHA case files (Ex: 502-22)
215	Nursing Care	805	This nursing center has established a practical ergonomics program stressing the safe bio-mechanical lifting of residents. This is presented to their staff through lectures, videos, handouts and demonstrations. It is repeated on a semi-annual basis. Mechanical lifting assists have been made available throughout the establishment.	Reduced the number of associated lost work-days by over 85%.	In 1997 and 1998 the practical ergonomics program stressing safe bio-mechanical lifting techniques at this small nursing care facility, cut the rate of related workplace injuries by almost 75% from what they were in 1996.	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
294	Health Care Facility	805	Introduced mechanical lifts in four high risk units.	Not Reported	Average reduction in injuries over the 4 units was 73.75%. A similar facility in Wyoming also reduced injuries by 60% after mechanical lifts were introduced..	Testimony of Guy Fragala, PhD., PE, CSP. (Ex. 37-4)
300	Health Science Center	805	Ergonomics program included interventions such as worker assisting devices, equipment to help employees move patients. Training was also incorporated.	Lost time hours were reduced by 43% and in one selected nursing unit, it was reduced by 83%.	Back injury incidence rates fell 23%. In one selected nursing unit, there was a drop off of 39% in back injuries.	Testimony of Guy Fragala, PhD., PE, CSP. (Ex. 37-4)
214	Nursing Care	805	An ergonomics program stressing biomechanical safe lifting was begun in 1997. The program is administered and reviewed by an in-house ergonomics committee. It is audited by their corporate office on an annual basis.	Lost work-days associated with injuries have been reduced by more than 80%.	In the last two years this small nursing care facility's practical ergonomic program of bio-mechanics has cut their rate of ergonomics-related injuries by more than half.	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
150	Nursing Care	805	The company contracted with a manufacturer of lift assist devices to assess their need for lifts, train their employees initially on the use of the lifts, and then follow up with additional training and other support. The employer purchased 7 lifts. Some were whole body lifts, and others were stand assist lifts. They then implemented a policy to require the use of the lifts for all resident transfers for residents that were less than 50% ambulatory. Employees who violated this policy were disciplined. This program had the full support and backing of management. The program was fully implemented in February of 1998.	The LWDII rate for the facility in the first 6 months of the program dropped to 3.9.	Not Reported	OSHA case files. (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
211	Health Care Facility	805	In 1993, the hospital formed a Back Injury Prevention Task Force to identify and tackle back injuries. The team created department-specific recommendations for the work process through a multi-disciplinary approach. For instance, in the nursing department, which accounted for half of all back injuries, nurses began to use mechanical lifting equipment, slide boards and patient transfer belts. Further, a trained colleague taught nurses how to lift patients properly.	Lost time injuries were cut to 49 (down 35%) with 426 lost days (a 57% decrease) and 1,851 restricted days (a 54% decrease). Total workers' compensation costs related to back injuries in 1994 were estimated at $187,595, a 43% decrease from 1993.	In 1994, total back injuries had decreased to 85 (a 43% decrease from 1993), with 38 occurring in nursing (a 50% decrease).	Back program cuts comp costs, injuries, lost days," *Hospital Employee Health*, (July 1995). (Ex: 502-22)
305	Residential Institute	805	Program includes management support, employee participation, job-site analysis, purchase of equipment, workplace modifications, training, rehabilitation, and fitness programs.	Workers' compensation claims reduced by $150,000 (13%) in one year. Cost related to back injuries were reduced by 32%.	Carpal tunnel syndrome claims were down 50%.	Testimony of Bernice D Owen, PhD, RN (Ex. 37-5)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
196	Nursing Care	805	In 1996 this nursing care facility strengthened its ergonomics program directed at the risks associated with the lifting of patients. They brought new mechanical lifting equipment into use in the facility and began an intense training program covering the use of both the equipment and proper procedures for making safe lifts. They also implemented a progressive disciplinary program to ensure the new policies were observed.	Cut the number of lost work-days injuries from 473 to 16.	By strengthening their ergonomics program in 1996, this nursing care facility reduced their rate of related occupational injuries from 1995 to 1997 by more than 75%.	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
146	Health Care	805	In June of 1997 the company established a no-lift policy. The program is called Get A Lift Workplace Program by Prevent, Inc. In the program each resident is assessed for the need for mechanical lift assistance and for the type of lift indicated (MAXI or SARA). The facility has two MAXI lifts and two SARA lifts. Color coded stickers are used to denote the type of lift to be used. The stickers are applied to the resident name plates outside the room. The staff is trained on both types of lifts. Use of lifts is strictly enforced. Management had initial problems with staff acceptance, but is pleased with their buy-in now.	Although it was already half way through 1997 when the company strengthened their ergonomics program, their rate of lost time injuries and the number of associated lost work-days were both still down by 50% for the year, compared to 1996 levels.	Not Reported	OSHA case files (Ex: 502-22)
145	Health Care	805	The company significantly strengthened their ergonomics program in 1997. They instituted a no-lift policy (exceptions are made for some patients due to their families' objections) and added mechanical lift assists to their facility. Training was provided to their staff on the use of the new equipment and safe lifting techniques.	Not Reported	After implementing an ergonomics program in 1997, this small health care facility achieved a 50% reduction in their related injury experience.	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
227	Nursing Care	805	In 1996 this facility implemented an ergonomics program. Mechanical lift assist devices were purchased and put into use. The staff received training on the new equipment and the procedures for performing lifts safely. A medical management program stressing early reporting of pains and symptoms was instituted.	In the first year following the implementation of an ergonomics program in 1996, this facility reduced their ergonomics-related lost-time injuries by two thirds, and the lost days associated with them from 748 to 111.	Not Reported	OSHA case files (Ex: 502-22)
101	Nursing Assistants, Nursing Home	805	Implemented program to determine patient lifting tasks that were the most stressful; evaluated alternative devices for acceptability among assistants; trained assistants in use of devices; and modified shower rooms and patient care techniques to facilitate patient handling. Used walking belts and mechanical hoists for lifting aids.	Decrease from 634 lost workdays/100 FTEs before intervention to 317 lost workdays/100 FTEs post intervention.	Incidence for back injuries decreased from 83 to 47 per 200,000 work-hours.	Garg and Owen (undated) (Ex. 26-1093) (Ex. 37-5)
102	Nursing Aides, Nursing Home	805	Committee of employees determined the types of mechanical devices that were needed, installed in 1993. Implemented employee training and modified duty programs.	Decrease in lost work days from 38 in 1991 to 4 in 1994 (as of Nov), largely attributed to the implementation of a no-lifting greater than 50 pounds policy.	Not Reported	Comments to OSHA from Kennebec, (undated) (Ex. 26-1094)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
243	Nursing Care	805	This facility decided to start an ergonomics program, including an ergonomics training program that emphasizes proper lifting and transfer techniques. Powered lift assists have been purchased and put into use. Two part time physical therapists provide ergonomic support to the nursing staff. Review of ergonomics related incidents and refresher training have been added to their program.	In the first year (1998) following initiation of their ergonomics program, this small nursing care facility cut their occupational injury rate by a third and their lost/restricted work-days by over 50%.	Not Reported	OSHA case files (Ex: 502-22)
194	Nursing Home	805	In 1996 they established an ergonomic component of their overall safety program aimed at primarily the handling of residents and office ergonomics. They focused on an employee-driven program with a strong training emphasis. They added electronic patient lifts to their stock of hydraulic lifts.	They have had a dramatic reduction (over 50%) in their lost-time ergonomic injury incidence and severity rates. They have saved over $100,000 in direct injury costs in the last four years. They have improved their continuity of resident care and the morale and pride of their employees.	Not Reported	Sherry Welch, Citizens Memorial, Bolivar, MO Phone call 7/13/99 (Ex: 502-22)
138	Nursing Care	805	The facility purchased a new Hoyer Lift and established a safety initiative program.	Compared with 1997 rates, the facility in 1998 cut their incidence of total lost time injuries and back injuries by over 50%. The severity of those injuries was also greatly reduced.	Not Reported	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
236	Nursing Care	805	In 1997, this facility established an ergonomics program. They abolished the practice of single person lifts and instituted the use of gait belts. Their physical therapy department evaluated the handling requirements for each resident and provided this information to the nursing staff.	By instituting an ergonomics program in 1997, this small nursing-care facility was able to cut their rate of ergonomics related injuries in half in each of the succeeding two years and cut the associated lost work days by more than 90%.	Not Reported	OSHA case files (Ex: 502-22)
316	200- Bed Acute Care Facility	805	Use a specialized "Lift Team" for lifting of patients which is specially trained for this task. Also, use of mechanical equipment.	In 1996 & 1997, had 11 and 9 reported lost time injuries, 23 and 31 lost days, with a cost of $20,632.00 and $63,796.00 respectively. In 1999, the year of implementation, had only 2 reported injuries with no lost days and 2 restricted days with a cost of $336.00	Not Reported	(Ex: 32-311-1-8)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
136	Health Care	805	In 1997 the company began an aggressive ergonomics training/in-service program. They provide gait belts for each nursing employee. There are three mechanical lift devices located throughout the facility and the lifting techniques and proper lifting training given during orientation and frequent in-service training are administered by the physical therapy and rehabilitation staff. This training includes critiques of staff actually performing transfers from wheelchairs and floor situations.	The severity of injuries that did occur after program implementation, as reflected in the number of lost working days associated with them, was down significantly.	After aggressively training their staff in the ergonomics of proper lifting techniques in 1997, this employer's incidence of related back injuries and upper extremity musculoskeletal disorders in 1998 was reduced by 80% from their 1996 experience.	OSHA case files (Ex: 502-22)
117	Nursing Home	805	The nursing home implemented a federally-funded injury-prevention project with UCLA's Occupational Safety and Health Program. Vale Health Center established a labor-management committee to review injury problems. It purchased old patient-lifting equipment with easier-to-use electrically powered lifts. Nursing aides also attended injury-prevention training sessions.	Not Reported	The company reduced back injuries from 10 per year to only one during the first six months after implementation of the ergonomics program.	*Los Angeles Times*, (July 25, 1997) (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
296	Health Care Facility	805	Hospital-wide quality management initiative that included an ergonomics -based back injury prevention program involving mechanical lifting devices.	Workers' compensation costs for back injuries were reduced from $174,412 to $4,500. Lost work days were reduced from 1025 to 81.	They achieved a 74% reduction in back injuries over a 3-year period.	Testimony of Guy Fragala, PhD., PE, CSP. (Ex. 37-4)
237	Nursing Care	805	At the start of 1997 this facility established an ergonomics program. Their physical therapy group was assigned responsibility for analyzing the handling requirements for each resident and providing this information and training to their nursing staff in the biomechanics of proper lifting and newly established policy on resident lifts. Single person lifts were prohibited and mechanical lift assists made available.	Since instituting their ergonomics program early in 1997, this small nursing-care facility reduced the number of lost workdays by over 85% over the next two years.	Since instituting their ergonomics program early in 1997, this small nursing care facility over the next two years cut their number of ergonomics related injuries by two thirds.	OSHA case files (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
129	Health Care	805	The facility asked Colorado Compensation Insurance (CCIA) to evaluate the worksites for affected employees. CCIA compiled data on injuries that met six criteria: *The injury occurred at the facility *The injury occurred in 1995 *The injured worker was in a clerical, administrative function *The injury was caused by a cumulative trauma to the hand, wrist, arm or neck *The injured person received physical therapy *The injury did not become a lost time case within 30 days from the date of the injury report (a lost time case is defined as one resulting in 3 or more days away from work).	Of the cases receiving interventions, only 5 resulted in lost-time cases; the remaining 67 were non-lost time cases. Of these 72 cases, the average cost per case was approximately $2,959. The cases that did not receive interventions cost approximately $4,652 per case.	Not Reported	Patricia Fernberg, "Health Returns from Ergonomics," *Occupational Hazards*, (10/1/98). (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
322	Three Nursing Homes	805	Implemented a zero-lift policy.	Achieved an: 80% reduction in lost or restricted workday injuries from patient transfers; 62% reduction in all lost or restricted workday injuries; and, 80.6% reduction in worker compensation cost from nursing departments and a total reduction of 75% per hospital. The number of lost or restricted workdays per year decreased 84.6%.	Not Reported	(Ex: 30-4779-1)
126	Nursing Care	805	Beginning in 1996, this employer implemented a good ergonomics program. They began a "no unassisted lift" policy. A body mechanics and lifting training program was added. All staff were provided with gait belts and training on their use. Mechanical lift assists were also purchased for each nursing wing and the bathing facility and put into mandatory use.	The company's LWDII rate fell from 35.8 in 1996 to 16.2 in 1997.	The facility implemented an ergonomics program in1996 and was able in the first year to achieve a 50% reduction in their rate of associated workplace injuries. The severity of the injuries that are occurring is also decreasing.	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
125	Nursing Care	805	In 1996 when new management took over this nursing care facility a decision was made to strengthen the ergonomics program, especially as it related to back injury prevention. Training in safe lifting techniques and back biomechanics was provided. An additional mechanical lift for resident transfers was purchased and put into use.	By strengthening their ergonomics program in 1996, this employer cut their rate of related lost-time injuries in half in 1997.	Not Reported	OSHA case files (Ex: 502-22)
195	Nursing Care	805	This facility began to implement an ergonomics program in 1995. An ergonomics consultant from Healthline assisted with pre-assignment job screening and defining the management and staff responsibilities for implementation of the new program activities. The administrator reviews all accident investigations to ensure causal factors and corrective actions are identified and implemented. There is a modified/restricted duty program in place. There are mechanical lifts available in all three divisions. A training program has been established covering the proper use of lifting equipment and lifting techniques. Unassisted lifts are prohibited.	Not Reported	From 1995 to 1997, the ongoing implementation of this nursing care facility's ergonomics program resulted in a 50% reduction in both the rate of back injuries incurred by its staff nurse aides and the lost work-day rate associated with those injuries.	OSHA case files (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
359	Nursing Care	805	They purchased various new lifting devices and made their use mandatory. Extensive training on proper use of equipment and patient handling.	Reduced the overall total lost time injury and illness rate by 75% between 1996 and 1998.	Lost-time back injuries and upper extremity MSDs declined from 9 to 2 cases between 1996 and 1998. The lost-work-day injury incidence rate for certified nurses aides declined from 20.3 in 1996 to 5.9 in 1998.	(Ex. 502-404)
363	Nursing Care	805	They purchased and put into use mechanical patient lift assists. Training on lifting is mandatory.	Reduced the total lost-time injuries and illnesses by approximately 50%.	Reduced the number of back injuries and upper-extremity MSDs by approximately by 50% between 1996 and 1998.	(Ex. 502-404)
365	Nursing Care	805	Implemented an ergonomics program that included thorough job safety hazard analysis, extensive employee training, and a strong back to work rehabilitation policy.	After implementing an ergonomics program in 1996 they had a 95% decrease in lost work days associated with ergonomic-related injuries.	As of May 1998, they have had only one recordable back injury with one lost work day.	(Ex. 502-404)
375	Nursing Home	805	They established a no-lift policy and purchased the mechanical lift equipment and established an ergonomics training program to support proper implementation and use of the new equipment.	In the second year after establishing a new comprehensive program, they achieved a 75% reduction in lost work-days.	In the second year after establishing a new comprehensive program, they achieved a 68% reduction in workplace injuries.	(Ex. 502-404)
360	Nursing Care	805	They made lifting equipment available on all resident floors and prohibited the use of single-person lifts. Also yearly in service training about patient handling and body mechanics.	Reduced the number of lost work-days from 170 in 1996 to 124 in 1997 and 44 in 1998.	Reduced the number of total lost-time-back injuries and upper extremity disorders from 7 in 1996 to 2 in 1997 & 1998.	(Ex. 502-404)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
338	Long Term Care Facility	805	Ergonomics-based back-injury prevention program, including lifting devices.	Over 3-year period lost-work-days reduced from 1025 to 81. Workers' compensation costs reduced to $4,500 from $174,412.	A 74% reduction in back injuries over 3 year period.	(Ex. 500-47-10)
374	Nursing Home	805	A "no-lift policy was established that required nursing personnel to use new mechanical lifts for lifting all residents. Training was provided on the ergonomics of lifting as well as on the new lifts.	In the first year following the implementation of their program, their total workers' compensation costs reduced from $19,000 to $118.	In the first year following the implementation of their program, their back injury claims related to sprains and strains were reduced from twelve to one.	(Ex. 502-404)
366	Nursing Care	805	The program addresses training, personal protective equipment, engineering control methods and medical monitoring.	The ergonomics program at this mid-sized nursing care facility reduced the rate of total lost time injuries and illnesses by 40% between 1996 and 1998.	The ergonomics program at this mid-sized nursing care facility reduced the number of back injuries and upper extremity MSDs by 40% between 1996 and 1998.	(Ex. 502-404)
344	Nursing Home	805	Instituted a joint labor-management back-injury prevention program. Consists of 10 members covering different shifts, and is co-chaired by the staff developer and shop steward. Additional equipment became available. Awareness training for LVNs was conducted.	Not Reported	Incidence rates remained relatively unchanged between 1996 and 1997 however, severity rates went from 143 in 1996 to 64 in 1997 per 100 worker-years. The severity rate for all musculoskeletal strain/sprain type injuries went from 196 to 89/100 worker years.	(Ex. 500-20-5)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
315	10 Hospital Study	806	A special "Lift Team" was developed utilizing specially trained and skilled people for lifting only. Trained for 2 days (16 hours) in latest techniques and equipment. Also included use of new mechanical lifts.	All 10 facilities showed a mean reduction in lost-work-days of 90%.	All 10 facilities showed a mean reduction in: back injuries of 69%, and incidence rates of 62.5%.	(Ex: 32-311-1-3) (Ex: 38-119)
298	Hospital	806	High risk processes were identified and priorities set for ergonomics interventions. Two high-risk units were identified and new lifting devices were instituted.	* Lost work days for one unit were reduced from 69 to 0 and restricted work days from 122 to 2. * Lost work days for the other unit were reduced from 48 to 0 and restricted days from 11 to 4.	* One unit achieved an 83% reduction in the number of occupational injuries. * The other unit achieved a 75% reduction in the number of injuries.	Testimony of Guy Fragala, PhD., PE, CSP. (Ex. 37-4)
292	Hospital	806	Implemented training and work practices, which included standardization of lifting procedures, an apprenticeship program for new workers, and use of mechanical lifting and transfer aids.	In 2 years, achieved a 74% decrease in lost time injury. Total lost days decreased from 136.2 to 23 per 100 FTE. Compensation costs decreased from $ 237/FTE to $139/FTE.	In 2 years, there was a 50% decrease in total OSHA recordable's.	Testimony of Bradley Evanoff, MD, MPH. (Ex. 37-1)
340	Hospital	806	Implemented lifting aids on two high risk units.	Lost-work-days were reduced from 69 to 0, and restricted days reduced from 133 to 6.	Occupational injuries improved approximately 80%.	(Ex. 500-47-10)
341	Hospital	806	Instituted a no-lift policy.	Not Reported	Reduced injuries by 95%.	(Ex. 500-47-10)
299	Hospital	806	Ergonomics program included the development of a no-manual-lifting policy with standardized lift and transfer procedures for patients.	Not Reported	Injuries were reduced by 95%.	Testimony of Guy Fragala, PhD., PE, CSP. (Ex. 37-4)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
304	Hospital	806	A comprehensive ergonomics system was implemented which included items such as patient assessments, purchase of assistive devices, education and training, new management policies for workers to follow, monitoring of the program, and management support.	Initially, there were 64 lost work days and 15 transitional or restricted days. 18 months later there were 3 lost work-days and 12 transitional days. 5 years later, there were no lost work-days.	Initially, there were 20 back or shoulder injuries, 18 months later that was reduced to 12 (40%).	Testimony of Bernice D Owen, PhD, RN (Ex. 37-5)
301	Hospital	806	Ceiling-mounted lifts were installed in a 200-bed facility.	Hospital was experiencing 26 lost-time injuries per year, based on 4 years of data, with an average of 938 lost days per year. In 2 years since new lifts were introduced, injuries dropped to 6.5 per year and lost days to 67 per year.	Not Reported	Testimony of Guy Fragala, PhD., PE, CSP (Ex. 37-4) (Ex. 500-47-10)
302	Hospital	806	Ergonomics management program and engineering control intervention were implemented. Mechanical lifting devices were installed.	In 1990, they experienced 1,097 lost-work-days. By 1995 they had reduced lost-work-days to 48.	Not Reported	Testimony of Guy Fragala, PhD., PE, CSP (Ex. 37-4)
297	Hospital	806	Quality improvement team determined that effective patient handling devices were needed as part of their intervention strategy. Started using lifting equipment.	Annual direct costs associated with back injuries resulting from patient handling based on an average of 3 years was $111,159. One year after new mechanical devices were introduced this was reduced to $743.	Not Reported	Testimony of Guy Fragala, PhD., PE, CSP. (Ex. 37-4)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
293	Hospital	806	Changes were made to billing office persons' workstations such as adjustments to computer keyboards and monitor setups and adjustments in seats and desks layouts.	Annual total days declined from a rate of 51 days per 100 FTE to 25 per 100 FTE. Compensation costs decreased from a high of $578 per FTE to a low of $120 per FTE.	Not Reported	Testimony of Bradley Evanoff, MD, MPH. (Ex. 37-1)
288	Hospital Employees	806	Implemented a comprehensive intervention that included case management, treatment by physicians experienced with work injuries, and use of ergonomic work.	A decrease in time lost from 10.4 to 6.6 days, and a 18% reduction in total case cost.	A decrease in musculoskeltetal injuries. Further, the program resulted in a pronounced decrease in the number of work-related upper extremity MSDs and a virtual elimination of cases which required surgery.	Testimony of Bradley Evanoff, MD, MPH. (Ex. 37-1)
317	Hospital/nursing	806	Use a specialized "Lift Team" for lifting of patients which is specially trained for this task. Also use of mechanical equipment.	They went from 39 cases per 1000 year observation to 2.4 cases per 1000 year observation. A 95% reduction in lost time injuries.	Not Reported	(Ex. 38-42)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
382	750-Bed Medical Center	806	In 1993, a comprehensive ergonomics program using the 5 step approach was implemented. One component of their program was the implementation of an ergonomics team with representation from each of the major departments.	These efforts were a part of the reason for the reduction in lost-work-day incident rate from 5.9 to 4.0 for calender year 1993 to 1994. Their lost-work-day incident rate continue to improve, reaching 3.3 in 1997. This compares to an industry average for hospitals in 1997 of 4.1. They went from significantly worse than industry average to significantly better.	Not Reported	(Ex. 500-50-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
255	Hospital	806	Initiated a comprehensive ergonomics program in 1992. The program consisted of early diagnosis and treatment of upper-extremity MSDs along with identification and correction of problem jobs. The program emphasized early detection of problems by providing that any worker with a complaint that could "possibly" be related with an upper-extremity MSD was medically evaluated and an ergonomic survey/job analysis of the employee's workplace was conducted to determine the work-relatedness of a potential worker's compensation claim and to initiate corrective action.	Not Reported	In the seven- year period following the 1992 initiation of this ergonomics program, the rate of upper- extremity work-related MSDs decreased significantly by 80 % from 6.5 per 1,000 in 1992 to 1.3 per 1,000 in 1998.	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (Bernacki et al., 1999) (Ex:32-339-1)
103	Nurse, Hospital	8062	Professional lifting team of 2 performs 95% of all patient lifts; nurses freed to do more nursing activities.	Not Reported	Back injuries reduced 94% first year after teams were implemented	Charney et al. (1991) (Ex. 26-1091)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
104	Nursing and Laundry Workers, Hospital	8062	Worker education and training were provided. Employees were encouraged to take breaks. A regular maintenance program for equipment was initiated. New hand tools and lifting equipment were provided. Handles were installed on tool carts. X-Ray cassettes were reorganized to avoid repetitive bending and back problems.	Lost-time hours in nursing ward fell 83 percent in 4 years. Lost-time hours among laundry workers fell 83 percent in 2 years.	Back injury rates in nursing wards fell 39 percent in 4 years. Back injury rates among laundry workers fell 71 percent in 2 years.	"Giving health-care workers a helping, mechanical hand." CTD News (1995) (Ex. 26-1092)
385	Hospital	8062	Steps involved in the process: 1. Define the exposures; 2. Identify the location and severity of negative results; 3. Identify existing and previously reviewed equipment to address exposure; 4. Determine new equipment and work practice needs	One facility's results: -reduced-lost-time cases from 43 to 7 over a two-year period. -productivity went up -reduced workers' compensation from $80,000 to $15,000	Not Reported	(Ex. 500-50-1)
384	450-Bed Hospital	8062	Applied the five-step approach and recognized that patient transfer was the primary loss-producing source that needed to be addressed.	These efforts resulted in a reduction in lost-work-days per 100FTE from 43.7 in policy year 92/93 to 20.5 in policy year 94/95.	Not Reported	(Ex. 500-50-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
106	Prescription Filling Using a Syringe, Hospital	8062	A manual assist for syringe actuation was developed to reduce the thumb and pinch grasp forces required while using a standard syringe. The system, about the size of a hot dog bun, accommodates standard syringe sizes from 10cc to 60cc.	Not Reported	Upper extremity CTD cases were reduced from six to one.	"Case study 60: Hospital pharmacy liquid IV prescription filling using a syringe." ErgoWeb Inc., 1998 (Ex. 26-1096)
107	Hospital Workers	8062	Patient Air Lift Systems introduced.	Not Reported	Reduced injuries at second hospital by 94%.	Brigham (1994) (Ex. 26-1097)
108	Nursing, Hospital	8062	Redesigned work process: Mechanical lifting equipment, slide boards, and patient transfer belts.	Lost-time injuries reduced to 49 (down 35%), with 426 lost days (a 57% decrease), and 1,851 restricted days (a 54% decrease).	In 1994 total back injuries decreased to 85 (a 43% reduction)	Hospital Employee Health (1995) (Ex. 26-1098)
383	230-Bed Hospital	8062	Implementation of an ergonomic program including the purchase of 13 Air-supplied mattress (i.e., transfer technology) devices.	The total cost for the devices was $22,000. The cost for patient transfer related incidents the two years prior to introduction was $272,380. The cost for the two years immediately following intervention was $73,117, a reduction of almost $200,000.	Not Reported	(Ex. 500-50-1)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
105	Nursing, Hospital	8062	Ergonomic assessment of 14-room surgical suite, implemented changes in procedures for moving patients, maneuvering carts and equipment, using gall bladder boards, walking on wet floors, and accessing power outlets. Workers are periodically retrained in procedures to maintain awareness.	Not Reported	Back injury rates reduced by 25% in 18 months since program was implemented.	Garg and Dockery (1995) (Ex. 26-1095)
345	Medical Center	8062	Interdisciplinary team established to prevent injuries and reduce workers compensation costs. Ergonomics team divided into three components, 1) Basic Ergonomics, 2) Medical Ergonomics, 3) Human Factor Engineering.	Workers' compensation claims were reduced from 10.49 per 100 FTEs in 1995 to 7.26 in 1999.	Not Reported	(Ex. 30-4139)
346	Hospital Billing Department	8062	Ergonomics program was conducted. Jobs selected that needed attention, employees were trained, and job modifications and equipment changes made (i.e. desk and chair heights, back support, foot and wrist rests, etc..).	Annual workers' compensation cost were reduced from $578/FTE to $120/FTE. Lost work-day injury/Illness rate dropped from 63.2/100 FTE to 6.4/100 FTE. Annual lost work-days was reduced from 51/100 FTE to 25/100FTE.	The number of work compensation injuries was reduced from 12/100 FTE to 5.4/100 FTE.	(Ex. 30-4139)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
172	Home Health Care	8082	The ergonomics program established by this employer relied heavily on training. This included training on back biomechanics and safe lifting techniques. They constructed a mock home health care setting at their training facility to allow hands-on practice.	Cut their workers' compensation costs by 50%.	Not Reported	OSHA case files (Ex: 502-22)
167	Educational Institution	82	They established an ergonomics assessment and implementation team to analyze their injury and illness data and identify when, where, and how their injuries were occurring. The ergonomic concerns they identified were addressed with job redesigns, equipment changes, training, and warm-up exercise programs. They stressed employee involvement in all phases of their program.	Three years after being invited to join the Maine 200 Pilot program this institution's ergonomics program had reduced their lost work-day injury rate and total lost work-days by over 95%. Their workers' compensation insurance costs had decreased by over $100,000 per year.	Not Reported	OSHA case files (Ex: 502-22)
342	Health Science Center	8733	Ergonomics program, lifting aid devices, staff training on device use.	Lost time hours have dropped 43%.	Back injury incidence rates have fallen 23%.	(Ex. 500-47-10)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
119	Municipality	91	Under one of San Jose's ergonomics programs, a job is analyzed over a number of days to identify high-risk activities. A training session was created to show workers how to work differently to reduce the risk of injuries. Aside from the specific instructions, the six-hour course also provides more general information on body mechanics, posture and breathing. Another program teaches employees proper typing techniques designed to reduce repetitive stress injuries. Finally, San Jose has made several improvements to employee workstations, including split keyboards and track balls instead of mouse.	The ergonomics program has helped save the city $5.7 million in workers' compensation costs since 1995.	In Fiscal Years 1996-1997, back injuries among city workers fell by 57.3%, while wrist injuries fell by 25.9%.	Michael Bradford, "Ergonomic Changes Comfort San Jose: Efforts to Reduce Workplace Injuries Save Millions and Help Workers Stay on the Job," *Business Insurance*, 10/26/98. (Ex: 502-22) (Ex. 32-339-1-66)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
229	Government	91	The State recognized the need for a statewide comprehensive ergonomics program with management commitment and employee involvement. Employees on the assessment teams recommended changes to the workstations such as adjustable chairs, document holders, wrist and mouse rests, footrests and adjustable height keyboard holders. For some workstations, no equipment was needed, but the assessment team recommended short breaks from keying. Another important component of the ergonomics program was training. Training on ergonomics was provided for employees and supervisors.	In the first two years, the ergonomics program decreased the cost associated with MSDs by 51%, and the cost has continued to fall. In 1998, Wisconsin had a 75% decrease from levels at the start of the program.	Not Reported	*Occupational Safety and Health*, (August 1998). (Ex: 502-22)
109	Government Employees	91	Introduction of program of ergonomic improvements, education, training, and physical fitness activities.	Not Reported	1-year prevalence of back pain fell from 65 to 53 percent.	Shi (1993) (Ex. 26-1099)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
349	VDT Operators		A committee was formed to identify alternative work patterns to increase work variability, reduce the amount of keying to no more than 5 hours per day, and evaluate new chairs. New chairs installed in February, 1991.	Not Reported	CTDs for Nov. 90 / Feb. 93 Neck 22.2% / 0.0% Shoulder 13.9% / 14.7% Elbow/ Forearm 8.3% / 5.9% Hand/ Wrist 36.1% / 20.6% Low Back 8.3% / 0.0	(Ex: 500-41-115)
274	Household Products Manufacturer		Introduced adjustable workstations, improved the grips on hand tools, improved parts organization and work flow.	Not Reported	Reduced all injuries (particularly back) by 50%.	"Summary of Studies on the Effectiveness of Ergonomic Interventions" (June 1995). (Ex. 38-65)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
204	Military		Identified a comprehensive program to address ergonomics base-wide. They established an ergonomics committee to identify workplace ergonomic stresses from their injury logs and to evaluate those high risk areas to prevent future injuries. Powered ergonomic tools were substituted for mechanical models. Task lighting was improved. Storage spaces were rearranged to eliminate bending and lifting. Electric lift tables and hoists were added. An ergonomics training program was put into place to help workers identify and minimize ergonomically stressful activities. The base's occupational medicine program was strengthened in its approach to workplace ergonomics.	Not Reported	Four years after establishing a comprehensive, practical and modestly funded ergonomics program, a high rate of ergonomic injuries were eliminated.	CTD News,(January, 1996). (Ex: 502-22)
373	Manufacturing-raw Material Processing		During 1989 thru 1991,the company purchased 27 electronic lift assists that it permanently mounted on its lift trucks.	Not Reported	Reduced the number of back injuries from 13 to 4 over a two-year period while improving product quality.	(Ex. 502-404)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
188	Manufacturing		The company developed a comprehensive ergonomics program, including the following: *An education program, including videotapes, seminars and instruction on proper posture, designed to teach computer users how to reduce exposure to ergonomic injuries. *A site on 3M's company intranet with information designed to help employees evaluate their workstations. *The development of new products, including a gel -illed wrist rest for computer users. *Using forklifts and "tote tanks" instead of manually maneuvering 55-gallon drums.	At one plant, lowered incidence of lost workdays from more than 50 days per 100 workers in 1991, to less than 20 days per 100 workers in 1994.	A study of 1,000 company employees over a 30-month period revealed that less than 11% still reported pain or discomfort after implementing all or part of the recommended ergonomics changes.	Profiting From Loss Control: 3M's Own Ergonomics Research Leads to New Products,"*Business Insurance*, 4/27/98; "Ergonomics Teams: Help Workers Help Themselves" *Safety & Health*, (2/96, pp. 55-56). (Ex: 502-22)
212	Manufacturing - Materials		The company established a very aggressive safety program and an ergonomics program. The company installed a lift to move 600-pound drums and purchased an auto-pallet loader to further minimize lifting and moving.	In 1996, the company had reduced its workers' compensation claims to 1,000 from 2,500 in 1987.	Not Reported	Company report to OSHA (Ex: 502-22)

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#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
333	Military		Implemented abatement program focused on tasks requiring excessive lifting, bending and repetitive arm motions centered around a joint labor management team for identifying hazards. Workers are trained and a medical monitoring program was developed.	Not Reported	RSI exposures at the plant have dropped dramatically. RSI injures in the parachute shop have essentially been eliminated. In four-year period prior to the program, 15 of 25 employees in the shop had been diagnosed with RSIs.	(Ex: 32-339-1-1)
311	Manufacturing		Redesigned totes for carrying of large and small parts to reduce cumulative wrist trauma disorders from repetitive lifting and maneuvering.	Not Reported	3 serious wrist cumulative-trauma disorders had occurred in the 4 years since the introduction of the new totes, they have not had one wrist cumulative-trauma disorder.	(Ex. 500-114)
268	Cable Forms Production		Introduced adjustable workstations and fixtures, counterbalanced tools.	Reduced musculoskeletal sick leave by 67% over an 8-year period, productivity increased.	Not Reported	"Summary of Studies on the Effectiveness of Ergonomic Interventions" June 1995 Ex. 38-65

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
115	Administrative Services		Work areas were evaluated for potential ergonomic risk factors and recommendations for engineering controls were made and implemented. In addition, a medical management program and an office ergonomics training program were established.	The number of hours lost due to occupational injury was reduced by 75%.	No new injuries were reported in the first year following full implementation of their program.	CTD News, (January 1998) (Ex: 502-22)
254	Gov't. Employees		Workers are trained in ergonomic practices and tracked to determine whether the program has been successful in reducing work related MSDs. The department incorporated hand-powered, portable lifting devices, tire-dunker machine, automated lubrication systems, etc.	During two-year period, reduced the number of lost work days from 225 to 68 (70% reduction).	During two- year period, reduced the number of MSDs from 86 to 39 (55% reduction).	"Ergonomics at the DoN" (Ex. 192)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
259	Computer Manufacturer		In 1991, this company initiated an ergonomics program incorporating a number of core elements, including management commitment, training, medical management, identification of high risk employees, hazard analysis and control.	During the period 1994 through 1998, OSHA recordable cumulative trauma disorder rates decreased in each of the four years, days away from work per lost day case declined from 14.67 in 1994 to 4.1 in 1998, a 72% decrease in the time away from work for each lost day case, and an avoidance of approximately 20,000 days away from work over the four-year period, accounting for more than $10 million in direct and indirect savings.	Not Reported	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (Ex:32-339-1)
381	16 Separate Companies and Consisted of a Wide Range of Materials Handling Jobs.		Intervention types included: 1. Lift tables 2. Lift aid 3. Redesign 4. Equipment	Not Reported	Ergonomic interventions consistently reduced the jobs' mean low back incidence rates.	(Ex. 500-87-1)
273	Office		Provided training, redesigned workstations, and incorporated additional breaks and exercise into the work schedule.	Average of all sick leave decreased from 20 days/year to 10 days/year in two years.	Not Reported	"Summary of Studies on the Effectiveness of Ergonomic Interventions" (June 1995). (Ex. 38-65)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
260	Office Setting		Initiated an ergonomics program in the late 1980's focused on an office environment. Their program incorporated a number of the core elements of a programmatic approach, including training, management commitment, job hazard evaluation and control, medical management, hazard identification and a pro-active element (engineering out hazards before equipment is put in place).	Total MSD claims severity (monies paid for MSDs) dropped despite an estimated 15% per year increase in medical costs. In addition, MSD claims payouts as a percent of total workers' compensation payouts declined from 66% of total dollars paid in 1992 to 48% of dollars paid (projected) in 1997.	Not Reported	Appendix C "Summaries of Studies on Effective Ergonomics Programs and Interventions" (United Services Automobile Association). (Ex:32-339-1)
267	Various (Insurance Co. Survey)		Program included training in lifting techniques, design of lifting tasks to fit worker capabilities.	Not Reported	Matching job demand to worker capabilities reduced injuries by 67%. There was a decrease of 33% in back injuries.	"Summary of Studies on the Effectiveness of Ergonomic Interventions" (June 1995). (Ex. 38-65)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
159	Television Assembly		The company initiated a four-step plan to eliminate WMSDs: Identify high risk tasks; educate managers and workers on proper ergonomic methods; adopt modified tools and redesign workstations; and institute mandatory job rotation. Mandatory job rotation proved to be the most effective method for preventing WMSDs.	Not Reported	The company experienced a 46% reduction in WMSDs during the first nine months following partial implementation of job rotation. Another study showed workers on mandatory job rotation lines suffered nine WMSDs during a four-month period compared to 42 for workers on lines where rotation was optional.	Job Rotation Cuts Cumulative Trauma Cases," *Personnel Journal*, (February 1992). (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
386	State Employees		Relocation of 1452 workers from various buildings to a single new building.	Not Reported	In matched multivariate analyses, the reduction in hand/arm symptoms from 1992 to 1993 was associated with improved satisfaction with the physical workstation; the reduction in neck/shoulder/back symptoms was associated with improved chair comfort, fewer housekeeping responsibilities, female gender and low pay range. Longitudinal results suggested that changes in workstations resulted in decreased symptoms.	(Ex. 500-41-100)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates		Sources
				Lost Workday MSDs	Total MSDs	
161	Data Processing Division		In the fall of 1992, the company devised an "action plan," which included hiring a safety and health specialist, allocating funds for the purchase of ergonomically sound furniture, and developing an ergonomics program. The five-step program includes: *A safety council comprised of both managers and employees. *Training classes for supervisors and employees. Supervisors are also required to conduct a workstation check every quarter. *Medical-case management requiring the nurse and safety coordinator to evaluate work-related injuries. *Frequent evaluation of new ergonomically safe equipment and technology. *Employee motivation, including monthly ergo activities like videos and exercises.	Workers' compensation decreased 51% between 1992 and 1994. The division of the company's customer service center responsible for processing credit cards and motor club accounts did not record any lost workdays due to CTDs during the first half of 1994.		*CTD News*, (5/94, p.3). (Ex: 502-22)

Appendix VI-B. Summary of Case Studies of Ergonomic Programs/Interventions

#	Job Title or Activity	SIC Code	Ergonomic Program/Interventions	Reported Reduction in Injury Rates: Lost Workday MSDs	Reported Reduction in Injury Rates: Total MSDs	Sources
121	Data Entry		To address the potentially serious ergonomic stresses in their workplaces, the company implements an informal, yet effective, employee-driven ergonomics program. Although there is an incentive pay system in use, employees are encouraged to pace themselves. There is a formal, written procedure in place encouraging employee input. Ergonomic guidance is prominently displayed in the workplace and accessories such as document holders, adjustable chairs and anti-glare screens are provided and encouraged.	A review of their workers' compensation data for the last four years showed an ergonomic-related claims rate of less than 0.1 per 100 employees.	Not Reported	"Office Ergonomic Solutions: Six Case Studies," Center for Office Technology, (1994, p. 39-41). (Ex: 502-22)
389	Assembly Workers		Incorporated parallel production, team building, multiple skills, and work place redesigns.		No change in task distribution and mechanical exposure variables.	BAO. et al. (1996) (Ex: 38-68)
390	Assembly Workers		Incorporated parallel production, team building and, multiple skills training.	Less satisfaction with psycho social environment.	Diverse physical exposure effects. No effect on MS health.	Johansson et. al. (1993) (Ex: 38-68)

Appendix VI-C. Summary of Effectiveness Measures Derived From Case Studies

Reference No. From Appendix VI-B	SIC	Percent Reduction in Lost Workday Cases	Percent Reduction in Total Cases	Time Period Covered (yrs)
1	20		47.0%	4
308	201	100.0%	71.4%	
197	2011	13.3%		2
198	2011		52.0%	
198	2011	19.0%	32.0%	1
185	2011		17.0%	1
128	2011		60.0%	
5	2011		80.0%	1
230	2011		68.0%	4
329	2011		50.0%	5
2	2011		100.0%	0.5
220	2011		85.0%	5
4	2011		63.0%	4
235	2015	50.0%		2
256	2015	30.1%	32.1%	3
291	2015		46.0%	5
372	2015		67.0%	3
310	2015		80.0%	4
6	2015		100.0%	
8	2015		41.7%	2
7	2015		60.9%	
7	2015		31.8%	
193	2015		92.0%	7
191	2015		80.0%	5
9	2024		100.0%	2
10	2048		100.0%	
11	205		61.8%	3
162	2051		60.0%	3
12	206		100.0%	
240	2086		40.0%	2
190	2092	96.9%		4
221	22		91.7%	7
330	22	24.7%	58.8%	1
140	22		82.6%	3
140	22		94.7%	3
142	2273		50.0%	4
336	23	-15.0%		1
141	23		36.4%	2
388	23		0.0%	
174	23	79.0%		
264	2431		95.5%	
15	2515		88.9%	1
17	252		50.0%	

Appendix VI-C. Summary of Effectiveness Measures Derived From Case Studies (Continued)

Reference No. From Appendix VI-B	SIC	Percent Reduction in Lost Workday Cases	Percent Reduction in Total Cases	Time Period Covered (yrs)
16	252		9.5%	1
168	26	50.0%		3
18	2621		100.0%	0.5
356	2621		43.5%	3
312	2670	70.0%	50.0%	4
20	27		100.0%	2
367	2711	75.0%	84.0%	4
120	2711	100.0%	45.8%	3
326	2711		40.0%	2
232	2732		67.6%	
252	28		82.0%	5
22	283	100.0%	62.0%	10
368	283		100.0%	2
155	283		87.0%	2
153	2834		61.5%	
219	2834		75.0%	1
23	2851	63.0%	40.0%	3
25	2911		90.0%	
352	30		90.0%	
362	3011	66.0%		1
26	3052	100.0%		
147	308	40.0%		1
263	3086	82.4%	85.9%	3
27	31	79.0%		
29	314		57.1%	3
30	314		100.0%	2
31	3149	67.0%	62.0%	2
323	3161	72.7%	87.5%	2
127	3161		83.8%	
32	3199		24.7%	2
33	3229	97.7%		2
34	3231		76.4%	9
35	3253	100.0%		4
241	326	60.0%		
36	3272	100.0%		2
37	33		100.0%	
38	33		83.3%	
306	33	100.0%		
112	3321		60.0%	2

Appendix VI-C. Summary of Effectiveness Measures Derived From Case Studies (Continued)

Reference No. From Appendix VI-B	SIC	Percent Reduction in Lost Workday Cases	Percent Reduction in Total Cases	Time Period Covered (yrs)
348	3341		50.0%	
348	3341		33.0%	
39	3350		50.0%	
40	34		100.0%	
41	34		100.0%	
42	3411		90.0%	
43	3452	80.0%		
44	3496	25.0%		2
45	3499	100.0%		5
151	35	100.0%		4
152	35		27.0%	
171	3511	70.0%		4
47	3523	83.0%		
48	3531		27.0%	
124	357		79.8%	4
370	357		46.9%	
52	3571	100.0%	100.0%	
50	3571		64.3%	2
53	3579		67.0%	2
361	3585	50.0%	90.0%	1.5
55	36		46.0%	1
157	36		28.0%	1
54	36		75.9%	1
56	36		100.0%	
57	36		29.0%	
183	36		100.0%	2
58	3641		100.0%	4
60	3661		76.4%	1
59	3661	80.0%		1.5
62	367		100.0%	
199	3672		46.9%	
213	3678		44.5%	3
66	371	48.0%	11.0%	3
65	371		100.0%	
64	371		93.0%	1
64	371		96.0%	
318	3711		72.1%	9
337	3711		100.0%	
156	3711		40.0%	2
178	3711		40.0%	

Appendix VI-C. Summary of Effectiveness Measures Derived From Case Studies (Continued)

Reference No. From Appendix VI-B	SIC	Percent Reduction in Lost Workday Cases	Percent Reduction in Total Cases	Time Period Covered (yrs)
154	3711		100.0%	3
270	3711	50.0%		
324	3711		26.0%	5
70	3711		100.0%	
72	3711		100.0%	
68	3711		67.5%	3
67	3711	65.0%	48.6%	2
71	3711		100.0%	
73	3714	100.0%		
77	3714	100.0%		
80	3714		100.0%	
81	3714		100.0%	
74	3714		100.0%	
76	3714		67.6%	2
75	3714	100.0%		
78	3714		100.0%	
262	3714		29.0%	
262	3714		78.0%	
79	3714	99.0%		4
184	3714		70.0%	
325	3714		24.0%	5
284	3714		53.0%	0.5
113	3714		50.0%	
313	3714		85.0%	4
158	3716		20.0%	
82	372		96.2%	4
332	3721		25.0%	1
224	3721		33.0%	6
328	3721		44.3%	6
170	3724	91.1%		3
83	3731	100.0%	30.0%	
223	3731	55.0%	30.0%	2
84	3751	33.2%		4
85	3823		100.0%	
179	384		70.2%	
277	380		17.5%	
309	384	100.0%	100.0%	
86	384		75.0%	
87	3841		46.2%	4
88	386		100.0%	3
357	3914		71.4%	
89	3944		100.0%	

Appendix VI-C. Summary of Effectiveness Measures Derived From Case Studies (Continued)

Reference No. From Appendix VI-B	SIC	Percent Reduction in Lost Workday Cases	Percent Reduction in Total Cases	Time Period Covered (yrs)
251	3991		80.0%	1
90	40	100.0%	100.0%	
246	4011	100.0%		
335	4151		33.0%	5
91	42		50.0%	1
92	4213	28.6%	46.2%	2
239	481		33.0%	2
93	481		51.0%	0.5
122	481		33.0%	
258	4911		100.0%	1
94	4911		100.0%	
387	4911		29.0%	
354	4911		25.0%	
282	495		73.6%	7
96	5137		91.7%	
97	514		42.9%	2
248	514		72.4%	0.75
207	5211	100.0%		2
131	53		60.0%	5
247	5311		50.0%	3
351	5411		44.7%	1
364	5411		76.2%	4
98	5812		40.0%	
99	5932		56.5%	2
177	60	50.0%		3
100	6021		70.4%	
355	63		90.0%	1
353	80	91.7%		
218	805		67.0%	
216	805	80.0%		2
176	805		16.3%	3
217	805		50.0%	2
209	805	71.1%	85.9%	3
295	805		75.0%	0.5
175	805	80.0%		2
166	805		40.0%	3
215	805		75.0%	2
294	805		73.8%	
294	805		60.0%	
300	805		23.0%	
214	805		50.0%	2

Appendix VI-C. Summary of Effectiveness Measures Derived From Case Studies (Continued)

Reference No. From Appendix VI-B	SIC	Percent Reduction in Lost Workday Cases	Percent Reduction in Total Cases	Time Period Covered (yrs)
211	805	35.0%	43.0%	1
305	805		50.0%	
196	805	96.6%	75.0%	2
146	805	50.0%		1
145	805		50.0%	
227	805	67.0%		1
101	805		43.4%	
243	805	33.0%		1
194	805	50.0%		3
138	805	50.0%		1
236	805	75.0%		2
316	805	100.0%		1
136	805		80.0%	2
117	805		90.0%	0.5
296	805		74.0%	3
237	805		67.0%	2
129	805	80.0%		
126	805	54.0%	50.0%	1
125	805	50.0%		1
195	805		50.0%	2
359	805	75.0%	77.8%	2
363	805	50.0%	50.0%	2
375	805		68.0%	2
360	805		71.4%	2
338	805		74.0%	3
343	805	75.0%		
374	805		91.7%	1
366	805	40.0%	40.0%	2
344	805		0.0%	1
315	806		62.5%	
298	806		83.0%	
298	806		75.0%	
292	806	74.0%	50.0%	2
340	806		80.0%	
341	806		95.0%	
304	806		40.0%	1.5
317	806	93.8%		
382	806	44.1%		4
255	806		80.0%	6
103	8062		94.0%	1

Appendix VI-C. Summary of Effectiveness Measures Derived From Case Studies (Continued)

Reference No. From Appendix VI-B	SIC	Percent Reduction in Lost Workday Cases	Percent Reduction in Total Cases	Time Period Covered (yrs)
104	8062		39.0%	4
104	8062		71.0%	2
385	8062	83.7%		2
106	8062		83.3%	
107	8062		94.0%	
108	8062	35.0%	43.0%	
105	8062		25.0%	1.5
346	8062	89.9%	55.0%	
167	82	95.0%		3
342	8733		23.0%	
119	91		57.3%	1
119	91		25.9%	1
109	91		18.5%	1
349			100.0%	2.5
349			-5.8%	2.5
349			28.9%	2.5
349			42.9%	2.5
349			100.0%	2.5
274			50.0%	
204			100.0%	4
373			69.2%	2
311			100.0%	4
212			60.0%	9
115			100.0%	1
254			54.7%	2
267			33.0%	
159			46.0%	0.75
159			78.6%	0.75
161		100.0%		0.5
389			0.0%	
390			0.0%	

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VII. Significance of Risk

In this section of the preamble, OSHA conducts several analyses and presents data and information to demonstrate, first, that musculoskeletal disorders (MSDs) constitute material harm under the Occupational Safety and Health Act (OSH Act or Act). This discussion demonstrates that MSDs are painful, often disabling injuries and illnesses that cause lost work time, require medical treatment, involve restricted work, and, all too often, result in surgical interventions.

The Agency then demonstrates the significance of the risk of incurring this material harm in the industries and occupations covered by the scope of the ergonomics standard. As OSHA's analysis shows, over a working lifetime, workers in jobs that meet the final rule's exposure screen face risks ranging roughly from 33 cases per 1,000 workers to 926 cases per 1,000 workers, risks that are clearly significant by any reasonable measure. Even on an annual rather than lifetime basis, many of the workers who would be covered by the standard are at great risk: nursing aides and truck drivers, for example, can expect to suffer between 32 and 42 lost-workday musculoskeletal disorders for every 1,000 workers in every year that they work. Again, that risks of this magnitude are significant within the meaning of the Act is not disputable.

Parts A and B below thus demonstrate unequivocally that the first two tests OSHA must meet before it can regulate—that the hazard regulated by the standard constitutes material harm and that the risk posed to workers covered by the standard is significant, as that term has been defined in OSHA case law—have been met. OSHA's response to comments received on its significance of risk analysis in the proposed rule appear in Part C.

A. Material Harm

The OSH Act requires OSHA to make a threshold finding that a significant risk of material harm exists in the workplace before issuing an occupational safety or health standard. *See Benzene,* 448 U.S. 607, 642; 58 FR 16612, 16614 (Mar. 30, 1993). What constitutes ''material harm'' in any particular case is, at bottom, a policy determination, for ''OSHA is not required to state with scientific certainty or precision the exact point at which each type of [harm] becomes [material].'' *See AFL–CIO* v. *OSHA (PELs)*, 965 F.2d 962 (11th Cir. 1992). As long as its determination is reasonable, OSHA is entitled to deference; however, OSHA must be cognizant of all forms and degrees of material harm—not just death or serious physical harm—and may act with a ''pronounced bias towards worker safety.'' *Building & Constr. Trades Dep't., AFL–CIO* v. *Brock*, 838 F.2d 1258, 1266 (D.C. Cir. 1988).

Injuries or illnesses that affect a worker's job performance, result in lost workdays or restricted work, and/or result in medical treatment beyond first aid constitute material harm under the OSH Act. See PELs, 965 F.2d at 974–75. This was confirmed by the 11th Circuit Court of Appeals in its review of OSHA's Air Contaminants Standard. In the Air Contaminants standard, OSHA set permissible exposure limits for over 400 substances to prevent the onset of certain health effects, including sensory irritation (*i.e.,* stinging, itching, and burning of the eyes, tearing (or lacrimation), a burning sensation in the nasal passages, rhinitis (nasal inflammation), cough, sputum production, chest pain, wheezing, and dyspnea). *Id.* OSHA found that in certain circumstances these effects were fleeting; however, substantial evidence in the rulemaking record suggested that these effects could be quite serious at times and could affect a person's ability to perform at work:

> ''OSHA concludes that exposure limits are needed for those substances for which PELs are being established in this rulemaking to protect against sensory irritant effects that result in objective signs of irritation, such as coughing, wheezing, conjunctivitis, and tearing. Such levels of mucous membrane irritation may require medical treatment, adversely affect the well-being of employees, and place the affected individuals at risk from increased absorption of the substance and decreased resistance to infection. Exposing workers repeatedly to irritants at levels that cause subjective irritant effects may cause workers to become inured to the irritant warning properties of these substances and thus increase the risk of overexposure.'' 54 FR 2444–45 (Jan. 19, 1989).

Industry representatives challenged OSHA's determination that these health effects constituted ''material impairment'' within the meaning of section 6(b)(5) of the OSH Act. *Id.* While OSHA conceded that minor irritation would not, by itself, constitute ''material impairment,'' it concluded that sensory irritation that resulted in medical treatment or affected job performance would constitute such impairment. PELs, 965 F.2d at 974. The court agreed with this finding:

> ''We interpret this explanation as indicating that OSHA finds that although minor irritation may not be a material impairment, there is a level at which such irritation becomes so severe that *employee health and job performance* are seriously threatened, even though those effects may be transitory. * * * Overall, we find that OSHA's determinations of what constitute 'material impairments' are adequately explained and supported in the record.'' *Id.* at 975 (emphasis added).

The OSH Act also permits OSHA to regulate a hazard to prevent the signs or symptoms of an injury or illness from becoming more severe and disabling. See Lead, 647 F.2d at 1252 (''We conclude that if OSHA could find on the basis of substantial evidence that preventing subclinical effects of lead disease would help prevent the true clinical phase of lead disease, the statute empowered it to set a blood-lead level goal to prevent these effects.''). The OSH Act does not require OSHA to wait until an injury or illness becomes so severe that employees become disabled before it has authority to regulate. Such an approach would turn the OSH Act from a statute designed to prevent injuries and illnesses from occurring to one that reacts to injuries and illnesses that have already occurred. This was not Congress' intent when it tasked OSHA with ''assuring as far as possible every working man and woman in the Nation safe and healthful working conditions.'' 29 U.S.C. 651(2)(b).

Based on the evidence discussed in this and other sections of the preamble, as well as all other evidence gathered by OSHA and placed in the public docket of this rulemaking, OSHA has concluded that MSDs as defined by this standard constitute material harm under the OSH Act. OSHA recognizes that these disorders are not life-threatening and that some of these disorders may be reversible, particularly if early intervention is provided. Nonetheless, evidence in the record shows that these disorders are debilitating (Brisson *et al.* 1989, Ex. 26–47; Vingard *et al.* 1991, Ex. 26–44; Berg *et al.* 1988, Ex. 26–46; Liss *et al.* 1992, Ex. 26–55; Webster and Snook 1994, Ex. 26–33; Binder and Hazleman 1983, Ex. 26–45; Boshuizen *et al.* 1990, Ex. 26–40; Blanc *et al.* 1996, Ex. 26–42; Liberty Mutual Research Center for Safety and Health, 1998, Ex. 26–54). These disorders cause persistent and severe pain, lost worktime, reduction or loss of the worker's normal functional capacity both in work tasks and in other of life's major activities, loss of productivity, and significant medical expenses. Where preventive action or early medical intervention is not provided, these disorders can result in permanent damage to musculoskeletal tissues, causing such disabilities as the inability to use one's hands to perform even the minimal tasks of daily life (*e.g.,* lifting a child), permanent scarring, and arthritis.

Furthermore, OSHA is triggering obligations on employers to respond to reports of MSDs only when such reports reach the level of severity sanctioned by the OSHA Act. Contrary to the allegations of some commenters, see *e.g.,* Ex. 30–3865; 500–187, this standard does not trigger employer obligations based solely upon employee reports of ''aches and pains.'' An employer is only required to respond to an employee report of an MSD when it: (1) Results in one or more lost workdays, one or more days of restricted work, medical treatment beyond first aid, or (2) includes signs or symptoms of an MSD that persist for 7 or more consecutive days, and (3) the employer is exposed to risk factors at the levels described in the Basic Screening Tool, which are associated with increased risk. MSDs that result in days away from work, restricted duty, or medical treatment beyond first aid clearly constitute material harm under the OSH Act, as described above. See PELs, 965 F.2d at 974–75. Moreover, it is clear that OSHA may trigger employer action upon employee reports of signs or symptoms of MSDs that persist for seven or more consecutive days. There is substantial evidence in the rulemaking record that persistent signs or symptoms of MSDs will progress and become more severe and disabling if they are not treated and the employee remains in the job unabated. See (Tr. 7660, 7884, see also (Ex. 32–450–1). OSHA need not wait for signs and symptoms of MSDs to become disabling to act; rather, OSHA may ''act to 'reduce the risk' of serious material impairment [at some point in the future].'' See Lead, 647 F.2d at 1253.

The pain associated with these workers is not the normal muscle soreness associated with job break-in or conditioning, or temporary muscle strain due to doing new or unusual tasks. Instead, the pain is severe and persistent. Many employees must be placed on medication to alleviate or at least reduce the intensity of their pain. The pain of MSDs may also continue or may even manifest after the employee is removed from exposure at the end of the workshift (Ex. 26-1263). In addition, the pain usually increases if exposure to the ergonomic risk factors continues (Ex. 26–1263). OSHA believes that this type of severe and persistent pain, and the tissue damage underlying this pain, clearly constitutes material harm under the OSH Act.

The Chamber of Commerce argued that OSHA should not rely on the testimony of injured workers to demonstrate that exposure to the risk factors at issue causes a significant risk of material harm because this testimony: (1) Includes MSDs that are not included in the rule; (2) contradicts trained physicians' findings; and (3) gives no consideration to potentially confounding factors. Ex. 500–188. But OSHA is not relying on this testimony to demonstrate that work causes MSDs or that this particular standard will reduce the incidence of MSDs, as the Chamber incorrectly suggested. Other evidence and data (described above) in the rulemaking record demonstrates this. The testimony of injured workers, however, is particularly probative in demonstrating how MSDs significantly affect peoples' lives. For this, statistics, epidemiological data, and other evidence are not alone sufficient. The testimony of these workers puts a human face on the pain and suffering experienced everyday by workers who suffer from these injuries. It also convincingly demonstrates that MSDs are not everyday ''aches and pains'' experienced by all, but serious, disabling conditions.

MSDs of most kinds are also recognized as compensable under virtually all State workers' compensation plans, and these disorders imposed nearly $20 billion in medical costs and industry payments on the U.S. economy in 1994 (see the Economic Analysis section of this preamble). Under workers' compensation, however, employees are reimbursed only where their work-related injury or disorder requires medical treatment and/or results in lost workdays. Moreover, payments for lost wages are not provided unless the employee's injury or disorder results in a certain number of lost workdays (the number varies across the States and ranges from one to seven days). According to evidence presented in the Economic Analysis, a significant number of musculoskeletal disorder workers' compensation claims result in lost workdays. For example, according to a study by Webster and Snook (1994, Ex. 26–33) based on workers' compensation data from Liberty Mutual Insurance Company, the largest underwriter of workers' compensation insurance in the country, more than 45 percent of all low back pain cases involved indemnity payments for lost workdays. This study also indicated that, on average, more than 65 percent of the workers' compensation costs for musculoskeletal disorders represented indemnity payments for lost workdays. Overall, work-related low back pain accounts for 15 percent of all Liberty Mutual workers' compensation claims and 23 percent of their costs (Liberty Mutual Research Center for Safety and Health, 1998, Ex. 26–54).

Further evidence of the disabling nature of MSDs comes from the Bureau of Labor Statistics (BLS) data for 1996, which show that the median number of lost workdays (LWD) per recordable lost-time MSD is higher than the median across all lost workday injuries (see Figure VII–1). For example, the median number of lost workdays for cases classified by BLS as carpal tunnel syndrome, tendinitis or tenosynovitis, or musculoskeletal and connective tissue disorders, is 25, 9, and 10 days, respectively. More than one-half of all carpal tunnel LWD cases and one-third of musculoskeletal and connective tissue disorder LWD cases result in more than 20 lost workdays, compared to less than one-fourth of all LWD injuries. Among workers who received compensation awards in 1994 for upper-extremity disorders, the average length of disability was 87 days, with 6.8 percent of the claims covering one-year or more of disability (Liberty Mutual Research Center for Safety and Health, 1998, Ex. 26–54).

Finally, several individual studies provide additional evidence demonstrating the disabling nature of MSDs. A study of female sewing machine operators showed an increased prevalence of disability among both retired and active workers compared to national rates of disability (Brisson *et al.,* 1989, Ex. 26–47). Operators who had left their jobs had a greater rate of severe disability when compared to workers who had left other types of employment. Vingard *et al.*(1991, Ex. 26-44) found an increased risk of early retirement among workers exposed to heavy or medium work loads due to disorders of the lower back, neck/shoulder, hip, or knee. An elevated incidence of long-term absenteeism and disability due to intervertebral disc disorders was found among tractor drivers, with the incidence appearing to increase with whole-body vibration dose and duration (Boshuizen *et al.*1990, Ex. 26–40). An analysis of data from the National Health Interview Survey showed that repetitive bending of the hand or wrist on the job was significantly associated with the frequency of self-reported carpal tunnel syndrome (CTS), and that work-related disability was common among the 544 subjects reporting CTS. The persistence of symptoms associated with MSDs is illustrated by two other studies. Berg *et al.*(1988, Ex. 26–46) studied the prevalence of MSD symptoms among 327 retired shipyard workers who had been engaged in heavy physical work and found that the prevalence of symptoms remained unchanged over a three-year period. In another study, Binder and Hazleman (1983, Ex. 26–45) followed the health status of 125 patients with lateral epicondylitis over a 1- to 5-year period after initial presentation of the disorder. Over the follow-up period, 40 percent of the patients continued to have discomfort that affected some daily activities.

OSHA has promulgated standards where the adverse health effects associated with exposure to substances or conditions are serious but not necessarily life-threatening, such as health effects that interfere with normal daily life or job performance, or that require substantial medical intervention. See Cotton Dust (29 CFR 1910.1046), Occupational Noise Exposure (29 CFR 1910.95), Occupational Exposure to Lead (29 CFR 1910.1025), Occupational Exposure to Formaldehyde (29 CFR 1910.1048). For example, in promulgating the Hearing Conservation Amendment, OSHA determined that ''* * * material impairment of hearing is directly related to people's ability to understand speech as it is spoken in everyday social conditions * * *.'' (46 FR 46236), including being able to understand speech in noisy environments. In the Formaldehyde standard, OSHA based its permissible exposure limit (PEL) and ancillary provisions, in part, on evidence that employees were at significant risk of developing sensory irritation (*e.g.,* burning and tearing of the eyes, severe irritation of the nose and throat) and skin diseases at the existing PEL, and that these effects were sufficiently severe to interfere with the employee's ability to perform job functions (52 FR 46168, 46234–37).

This standard is similar to these other OSHA standards in this respect. MSDs also result in material harm by causing temporary or permanent physical damage to the body. Such damage can include severe inflammation of joints and tissues; reduced conduction velocity in peripheral nerves; partial or total loss of strength in an extremity; tearing of muscles and tendons; numbness; decreased range of motion; arthritis; and pain. When this damage occurs, employees are unable to perform their jobs at all or at normal performance levels without experiencing pain or causing further damage. Accordingly, OSHA concludes that MSDs as defined by this standard constitute material harm under the OSH Act.

B. Significant Risk

As stated above, a plurality of the Supreme Court in Benzene held that the OSH Act requires a threshold finding that a significant risk of material harm exists and that the standard being promulgated will substantially reduce that risk. See Benzene, 448 U.S. 607, 642; see also 58 FR 16612, 16614 (Mar. 30, 1993). In so holding, the plurality noted that ''precise quantification of risks is * * * impossible'' given the imperfect state of scientific knowledge. Benzene, 448 U.S. at 652. Thus, while ''it is OSHA's responsibility to determine, in the first instance, what it considers to be a ''significant'' risk, * * * the requirement that a ''significant'' risk be identified is not a mathematical straitjacket * * * [and] the Agency has no duty to calculate the exact probability of harm.'' *Id.* at 655. Indeed, ''there are a number of ways in which the Agency can make a rational judgment about the relative significance of the risks associated with exposure * * *.,'' *id.* at 656–57, and ''so long as they are supported by a body of reputable scientific thought, the Agency is free to use conservative assumptions in interpreting the data * * *, risking error on the side of overprotection rather than underprotection.'' Id. at 656.

Since Benzene, OSHA has adopted a variety of methods for determining what constitutes a significant risk. See e.g., *Asarco, Inc.* v. *OSHA*, 746 F.2d 483, 490–95 (9th Cir. 1984); *Public Citizen Health Research Group* v. *Tyson,* 796 F.2d 1479 (D.C. Cir. 1986). With respect to section 6(b)(5) standards, OSHA has often utilized scientifically-based mathematical modeling techniques to determine risk at certain levels of exposure. This modeling permits OSHA to ''extrapolate [risk] * * * into areas where experimental [or observational] data do not exist.'' Public Citizen, 796 F.2d at 1496. With respect to non-section 6(b)(5) standards, however, OSHA has not needed to engage in quantitative modeling techniques to determine significant risk because it typically has observational data that quantifies the risk faced by workers to particular hazards. In the Electric Power Generation rulemaking, for example, OSHA found that the generation, transmission, and distribution of electric power and the non-use or misuse of appropriate electrical protective equipment resulted in 86 fatalities and 12,977 injuries annually and that the standard would prevent 61 fatalities and 1,634 injuries annually. Thus, the OSH Act does not require OSHA to construct dose-response relationships or other models for every hazard before it can regulate. OSHA has considerable leeway to choose a form of analysis appropriate to the available evidence and need not attempt to fit the evidence to a preselected analytical method.

There is no need, in the case of musculoskeletal disorders, for OSHA to engage in risk modeling, low-dose extrapolation, or other techniques of projecting theoretical risk to identify the magnitude of the risk confronting workers exposed to ergonomic risk factors. The evidence of significant risk is apparent in the annual toll reported by the Bureau of Labor Statistics, the vast amount of medical and indemnity payments being made to injured workers and others every year (nearly $20 billion in direct costs and as much as $60 billion more in indirect costs), and the lost production to the U.S. economy imposed by these disorders. Similarly, there is no need for OSHA to turn to complex theoretical projections of reductions in risk to demonstrate that the standard will substantially reduce this significant risk. Ergonomics programs work in practice. The evidence is there in the form of hundreds of epidemiological analyses, meta-analyses, and case studies reporting the effectiveness of ergonomic programs in reducing risk. The following discussion, and the analyses presented below, demonstrate the significance of the risk confronting workers in the industries and occupations targeted in the standard and make the case for the standard's effectiveness.

In this rulemaking there are, as mentioned above, extensive data on the adverse effects on the human musculoskeletal system of exposure to workplace risk factors such as repetitive motions; awkward postures; and the use of excessive force. As described in the Health Effects and Quantitative Risk Assessment sections of this preamble, studies and national statistics are available to demonstrate the high incidence and prevalence of work-related musculoskeletal disorders occurring or existing among workers exposed to ergonomic risk factors. Estimates of the risk of harm confronting exposed workers can be based directly on the rates of work-related musculoskeletal disorders currently being reported, and BLS survey data can be used to demonstrate the degree to which work-related musculoskeletal disorders have occurred across nearly all major industrial sectors and in numerous occupations.

The data discussed in the Quantitative Risk Assessment and

Health Effects sections of the preamble demonstrate that the risk of work-related musculoskeletal disorders constitutes a significant risk under the OSH Act. For example, OSHA estimates, based on the 1996 BLS data, that more than 590,998 lost-workday (LWD) musculoskeletal disorders occurred among workers in industries that are within the scope of the final rule, and that were recorded and reported by employers in 1996 (see Table VI–8 of the Risk Assessment). The estimated annual incidence of employer-reported MSDs (both upper-and lower-bound estimates), defined as the number of MSDs occurring in a given year per 1,000 workers employed in jobs that meet the final rule's exposure screen in each industry sector exceeded 1 LWD case per 1,000 workers for all but 3 of the 2-digit SIC general industry groups in 1996; the incidence exceeded 10 LWD cases per 1,000 workers in 15 of these industry sectors (see Table VI–5 in the Quantitative Risk Assessment section of the preamble). Further, OSHA estimates that the annual incidence of employer-reported LWD MSDs reached 1 case or more per 1,000 workers for 79 percent of all of the occupational groups for which BLS estimated the numbers of MSDs and employees. For 36 of these occupations, the estimated annual incidence of LWD MSDs exceeded 10 cases per 1,000 workers (Table VI–6 in the final Risk Assessment). For some high risk occupations, such as practical nurses, nursing aides and attendants, laborers, public transportation attendants, and truck drivers, annual incidence rates are on the order of 32 to 42 LWD MSD cases per 1,000 workers per year. These extremely high incidence rates, however, are underestimates of the true incidence of MSDs, because they are based only on lost workday cases. OSHA estimates that the number of MSDs that do not result in lost workdays is about twice that of LWD MSDs.

In the final Risk Assessment, OSHA also estimated the probability that an employee will suffer at least one musculoskeletal disorder due to workplace risk factors over a 45-year working lifetime as both an upper-and lower-bound estimate. The upper-bound estimate represents the lifetime risk to an employee who works in job that meets the final rule's exposure screen, and assumes that all of the risk is attributable to his or her workplace exposure to physical risk factors. The lower-bound estimate represents the lifetime risk to an employee in a job that meets the screen, but assumes that only part of that risk is attributable to exposure (*i.e.,* the rest of the risk is background). The results are presented by 2-digit SIC industry group in Table VI–9 of the Risk Assessment. The probability of experiencing at least one LWD MSD during a working lifetime ranges from 33 per 1,000 workers (lower-bound estimate in SIC 62, Security and Commodity Brokers, Dealers, Exchanges, and Services) to 926 per 1,000 workers (upper-bound estimate in SIC 45, Air Transportation). The expected number of MSDs that will occur in a cohort of workers all entering an industry at the same time and working for 45 years ranges from 34 per 1,000 workers to 2,530 per 1,000, depending on the industry sector, since it is possible for a worker to experience more than one MSD in a working lifetime.

The estimates of lifetime risk presented above are based on an assumption that workers in jobs that meet the final rule's screen are at three-fold higher risk than are workers in jobs that do not meet the screen. As explained in the final Risk Assessment, this assumption is well-supported by the data base of almost 200 epidemiological studies reviewed by the Agency and found to be of acceptable quality (see Section V, Health Effects). However, this assumption is not critical to the Agency's determination that the risks to workers exposed to biomechanical risk factors at the level of the final rule's screen are highly significant. In its final risk assessment, OSHA presented another analysis that is identical to that presented as part of the proposed rule. That analysis relies on BLS-provided estimates of the incidence of MSDs that is calculated across the entire working population; that is, the BLS-provided incidence figures do not recognize any difference in incidence of MSDs that occur between higher-risk and lower-risk workers. Even under that assumption, which minimizes the estimate of the risk to highly exposed workers, OSHA's estimates of lifetime risk are unambiguously significant. Estimates of the probability of experiencing at least one MSD over 45 years range from 24 to 813 per 1,000 workers, and the average number of MSDs predicted to occur over 45 years ranges from 24 to 1,646 per 1,000 workers (see Table VI–7 in the final Risk Assessment).

Although these data indicate that the risk of experiencing an MSD is clearly significant, OSHA believes that these data seriously understate the true risk. First, the BLS data capture only those MSD injuries reported by employers as lost workday injuries. MSDs that force an employee to be temporarily assigned to alternate duty, as well as those work-related MSDs not reported to employers by employees or not recorded by employers, are not included in these risk estimates.

Evidence of Underreporting

There is also evidence that the actual risks attributable to occupational exposure to ergonomic risk factors may be much higher than is indicated by the BLS statistics. Many peer-reviewed studies have been published in the scientific literature in the last 18 years that document the underreporting of MSDs on OSHA Logs (McCurdy *et al.,* 1999, Ex. 2–2; Silverstein *et al.,* 1997, Ex. 26–28 ; Pransky *et al.,* 1999, Ex. 26–922; Park *et al.,* 1992, Ex. 26–1259; Park *et al.,* 1996, Ex. 26–1261; Nelson *et al.,* 1992, Ex. 26–1260). Table VII–1 summarizes these studies. These studies document extensive and widespread underreporting on the OSHA Log of occupational injuries and illnesses in general (McCurdy *et al.,* 1999, Ex. 2–2) and of MSDs in particular (Silverstein *et al.,* 1997, Ex. 26–28; Fine *et al.,* 1986, Ex. 26–920; Pransky *et al.,* 1999, Ex. 26–922; Park *et al.,* 1992, Ex. 26–1259; Park *et al.,* 1996, Ex. 26–1261; Nelson *et al.,* 1992, Ex. 26–1260). Underreporting on the Log is directly related to OSHA's significant risk finding, because incidents that are not reported on the Log but should have been would downwardly bias the BLS annual survey numbers on which OSHA's risk estimates depend.

Since OSHA published the proposed rule, several commenters have provided additional information and comment, either through the submission of written comments and additional studies on underreporting to the docket, or through testimony at the hearing. NIOSH provided seven health hazard evaluations (HETAs), as described in the NIOSH pre-hearing comments (Ex. 32–450–1), that document extensive and widespread underreporting on the OSHA Log of occupational injuries and illnesses (NIOSH HETA# 88–344–2092, 1991 (Ex. 32–450–1); NIOSH HETA# 90–273–2130, 1991 (Ex. 32–450–1–13); NIOSH HETA# 92–331, 1993 (Ex. 32–450–1); NIOSH HETA# 95–0294–2594, 1996 (Ex. 32–450–1–22); NIOSH HETA# 97–0276–2724, 1999 (Ex. 32–450–1–2); NIOSH HETA# 96–0101–2476, 1997 (Ex. 32–450–1–26); NIOSH HETA# 98–0085–2715, 1998 (Ex. 32–450–1–10). These new studies have been incorporated into Table VII–1.

TABLE VII–I.—SUMMARY OF UNDERREPORTING STUDIES

Study	Measure of underreporting	Extent of underreporting observed	Additional detail
McCurdy, Schenker, and Samuels, *Am. J. Public Health.* 81:85 (1991) Ex. 2–2.	Percentage of cases meeting OSHA reporting criteria not recorded on OSHA Log.	40% of all reportable cases not recorded; for illnesses, 56% not recorded.	10 manufacturing facilities in 6 states from semiconductor industry with approx. 50,000 employees; 24% cases met OSHA recording criteria.
NIOSH. Health Hazard Evaluation Report, HETA 93–0233–2498, (1995) Ex. 26–1255.	Failure to report lost workdays and restricted work on OSHA 200 Log.	Not quantified; ''several'' employees had surgeries for WMSDs in 5-year period and ⅓ of employee were on restricted work, but no LWDIs reported on Log over 5-year period.	Winding and taping department of an instrument transformer manufacturer; 27 employees in department.
NIOSH. Health Hazard Evaluation Report, HETA 93–0860–2438, (1994) Ex. 26–1256.	Percent of medically confirmed WMSD cases not recorded on OSHA Log or not reported to employer.	5 employees reported to NIOSH that they had been diagnoses with carpal tunnel syndrome (CTS); of these, 2 did not report their illness to the employer. 1 of the 5 reported cases were not reported on log.	News department of large metropolitan TV-news station; video tape editor and other employees.
Silverstein, Stetson, Keyserling, and Fine *Am. J. Ind. Med.* 31:600 (1997) Ex. 26–28.	Incidence (per 100 workers years) of work-related MSDs, reported on OSHA 200 logs compared with cases that received medical treatment, as identified by self-administered questionnaire.	Plant/year; OSHA 200 Log; Self-report: Plant 1: 1986: 1.0; 30.9 1987; 2.7; 1988; 6.9; Plant 2: 1986: 0.9; 40.9 1987; 11.9 1988; 21.4. Plant 3: 1986: 20.3; 47.8 1987; 14.6 1988; 19.43. Plant 4: 1986: 0.7; 24.5 1987; 2.1 1988; 9.9..	Four automobile manufacturing plants. 713 out of 948 workers selected for the study completed the questionnaire.
Fine, Silverstein, Armstrong, Anderson, and Sugano, *JOM.* 28:674 (1986) Ex. 26–920.	Incidence (per 100 worker-years) of upper-extremity MSDs reported on OSHA 200 logs compared with workers' compensation (WC), medical absence records (MAR) and medical case records (MCR).	Plant; 200; OSHA WC, MAR, MCR: B; 0.03; 0.29; 3.04; 2.03 C: 0.15; 0.45; 1.85; 13.98	Data from two large automobile manufacturing plants (total employment not reported).
Pransky, Snyder, Dembe, and Himmelstein, *Ergonomics.* 42:171 (1999) Ex. 26–922.	Percent of workers reporting musculoskeletal symptoms caused or aggravated by work, compared to OSHA Log entries.	Work-related Symptom; % reporting; % on Log:. Hand/Wrist; 86%; 6% Arm; 33%; 1% Neck; 21%; 0 Back/legs; 28%; 2% 9% of workers reported that symptoms resulted in lost work days over the past year. 6% reported they were formally assigned light-duty work by plant nurse. 15% reported symptoms resulted in information light-duty work arranged by co-workers..	Questionnaire administered to 110 packers, of whom 98 responded. Plant produces variety of childrens' products.
Park, Krebs, and Mirer *JOEM.* 38:1111 (1996) Ex. 26–1261.	Number of claims made in a sickness and accident (S&A) disability (sick leave) system compared to lost-work-day (LWD) injuries and illnesses recorded in OSHA log.	Only 7 of an estimated 47 (15%) S&A upper extremity LWD cases in 1992 were recorded on the OSHA Log. For LWD back injuries, 27 of an estimated 36 (75%) S&A cases were recorded.	Study of an automotive assembly and stamping complex employing 10,000 workers.

TABLE VII–I.—SUMMARY OF UNDERREPORTING STUDIES—Continued

Study	Measure of underreporting	Extent of underreporting observed	Additional detail
Park, Nelson, Silverstein, and Mirer, *JOM.* 34:731. (1992) Ex. 26–1259.	Medical insurance claims linked to work histories compared to OSHA logs.	From 1984 to 1987, OSHA logs failed to record between 20 and 80 percent of occupational MSDs..	Conclusion based on authors' own unpublished data from insurance records of five automotive manufacturing plants. These records identified 11,577 MSD health claims made by 3,204 workers.
Nelson, Park, Silverstein, and Mirer, *Am. J. Public Health.* 82:1550 (1992) Ex. 26–1260.	Medical insurance claims linked to work histories compared to OSHA logs..	From 1985 through 1986, OSHA logs identified 59 hand/wrist MSD cases compared to 150 cases identified in health insurance records. For all MSDs from 1984 through 1987, only 9% of cases identified through insurance claims were recorded on OSHA logs (the authors cite data from Parks *et al.*(1992) indicating that about half of the upper extremity MSD cases from insurance claims are attributable to work.	
NIOSH Health Hazard Evaluation Report, HETA 88–344–2092 (1991) Ex. 32–450–1.	Percentage of workers with work-related (W–R) upper extremity (UE) MSDs not seeking medical care. W–R UE MSD cases defined by NIOSH standardized symptom questionnaires and positive physical findings from physician-conducted physical examinations.	40% of supermarket checkers with WR UE MSD did not seek medical care.	W–R MSD's not brought to the attention of a health care professional (HSP) will not be recorded on the OSHA 200 logs.
NIOSH Health Hazard Evaluation Report, HETA 90–273–2130 (1991) Ex. 32–450–1–13.	Percentage of workers with W–R UE MSD not seeking medical care and whether they were recorded on the OSHA 200 logs. W–R UE MSD defined by NIOSH standardized symptom questionnaires.	85% of employees with W–R UE MSD symptoms were not evaluated by a HSP. A small fraction of those with W–R UE MSD were recorded on the OSHA logs.	Jewelry manufacturing employees exposed to repetitive, forceful, and awkward postures during job tasks (MSD hazards).
NIOSH Health Hazard Evaluation Report, HETA 92–331 (close-out letter) (1993) Ex. 32–450–1.	Evaluation to determine compliance with OSHA corporate settlement agreement. Review of plant's health clinic algorithm to evaluate and treat symptomatic workers.	Large numbers of symptomatic workers evaluated by HAPS and prescribed a temporary job transfer. HSP deemed these as ''preventive'' job transfers and did not record these on the OSHA 200 logs.	Red meatpacking plant employees exposed to MSD hazards. BLS requires cases involving employees with W–R symptoms assigned a job transfer to be record onto the logs.
NIOSH Health Hazard Evaluation Report, HETA 95–0294–2594 (1996) Ex. 32–450–1–22.	Percentage of workers with W–R UE MSD not seeking medical care and whether they wer recorded on the OSHA 200 logs. W–R UE MSD defined by NIOSH standardized symptom questionnaires.	75% of employees with W–R UE MSD did not seek medical care. A small fraction of those with W–R UE MSD were recorded onto the OSHA 200 logs.	Research technicians conducting pipetting operations with MSD hazards.
NIOSH Health Hazard Evaluation Report, HETA 96–0101–2476 (1997) Ex. 32–450–1–26.	Employee health records and employee interviews compared with the plant's OSHA 200 logs. Same method used to determined the accuracy of the number of lost and restricted workdays recorded.	23% of employees with W–R UE MSD not recorded onto the OSHA 200 logs. The number of actual lost or restricted work days significantly under-reported.	Truck frame assumably employees exposed to MSD hazards. Under-reporting the lost or restricted workdays gives the impression of a less serious disorder.
NIOSH Health Hazard Evaluation Report, HETA 97–0276–2724 (1999) Ex. 32–450–1–2.	Clinic employee report of injury illness forms compared with the plant's OSHA 200 logs. Employee health records compared with the plant's OSHA 200 logs..	Many entries listed on the Clinic Employee Report of Injury/Illness forms and many cases from individual employee health records were not recorded on the OSHA 200 logs.	Fiberglass manufacturing plant employees exposed to MSD hazards.
NIOSH Health Hazard Evaluation Report, HETA 98–0085–2715 (1998) Ex. 32–450–1–10.	Comparison of workers reporting MS symptoms on a body map diagram with the OSHA 200 logs.	Several discrepancies between these two lists. Employees probably not reporting all W–R symptoms to employer.	Casket manufacturing employees exposed to MSD hazards.

As stated by NIOSH (Ex. 32–450–1), these HETAs compared the OSHA 200 Logs with work-related MSDs ascertained via the following mechanisms: (1) Confidential medical interviews; (2) review of employee medical records of private health care providers; (3) health surveys utilizing standardized MSD symptom questionnaires; and (4) health surveys defining cases as those with work-related symptoms and positive physical findings conducted by physicians performing physical examinations targeted to the musculoskeletal systems. In one HETA, NIOSH estimated the extent of the underreporting of recordable cases of MSDs on OSHA Logs as 23 percent of cases among a group of truck frame workers (Ex. 32–450–1–26). In other studies, NIOSH quantatively characterized the extent of the underreporting in these HETAs as ranging from ''a small fraction'' for jewelry workers and research technicians to ''many not reported'' for fiberglass manufacturers to ''large numbers not reported'' for red meatpacking plants; for a group of supermarket checkers, NIOSH quantitatively estimated that the underreporting amounted to 40% of all cases. NIOSH states that there is no reason to believe that these HHEs are not representative of the widespread underreporting believed to be associated with work-related MSDs. NIOSH suggested that OSHA include these HETAs in the final standard, to strengthen the evidence of MSD underreporting.

The rulemaking record thus contains convincing evidence that MSDs are often underreported; this evidence includes the new peer-reviewed studies submitted by several rulemaking participants. OSHA finds this evidence persuasive and has incorporated this information into this final standard, as appropriate.

Some commenters agreed that OSHA was correct in its assumptions about underreporting (see, *e.g.*, Exs. 32–339–1–34, –36 and –43, Tr. 3588, Tr. 4306–07, 4308, 6336, 7362, 7522, as reported in AFL–CIO, Ex. 500–218). Other commenters, however, questioned the accuracy of OSHA's estimates of the extent of MSD underreporting (see, *e.g.*, Exs. 500–197, 30–3845, 30–3813).

For example, Organizational Resources Counselors, Inc. (Ex. 30–3813) disagreed with OSHA's preliminary finding that MSDs are underreported on the grounds that: (1) The studies comparing workers' compensation data with OSHA Logs are more than a decade old; (2) OSHA's own audits (done in connection with OSHA's Data Initiative) of employer injury and illness records indicates a ''satisfactory'' level of reporting; and (3) factors such as aging and off-the-job risks affect the onset of MSDs and complicate the accurate reporting of work-related MSDs. In response, OSHA notes that many of the reports and studies it is relying on as evidence of underreporting are recent (late 80's and 90's) and that in this section of the preamble (Significance of Risk), OSHA is relying only on those studies that report underreporting on the Log (and thus may affect the BLS survey results). OSHA believes that ORC's argument that establishing the work-relatedness of MSDs may make them difficult for employees to report accurately only reinforces OSHA's point: that they are underreported on the Log. Finally, although OSHA agrees that OSHA's Data Initiative audits show a relatively accurate level of Log reporting, it is important to note that they do show that lost-time injuries are underreported by close to 15%.

In response to OSHA's request in the proposal for specific information on the underreporting or overreporting of MSDs, the AFL–CIO submitted additional studies to the docket supporting the underreporting of work-related MSDs (Ex. 500–218). Representatives from the AFL–CIO support OSHA's statements in the proposed rule to the effect that the BLS survey understates the true magnitude of the MSD problem by a factor of two (64 FR 65981). The AFL–CIO states that the record demonstrates that MSDs are indeed significantly underreported, thus supporting OSHA's determination on this point (see Ex. 32–339–1 at pp. 3–4). Further, at the hearings several physicians and researchers confirmed that there is significant underreporting. (See, *e.g.*, Dr. Armstrong, Tr. 839–40; Dr. Punnett, Tr. 1021; Dr. Erdil, Tr. 1115; Dr. Owen, Tr. 1886–87; Dr. Boden, Tr. 2399–2401.) Similarly, numerous workers explained that workplace injuries often go unreported to employers (Tr. 3588, 3602, 3612–13, 4510–11, 4587–89, 4595–97, 5601, 5820, 5861, 6068–69, 6381, 7546–7550, 7377–78, 7382–83, 7384–88, 7510–12, 7704). The AFL–CIO submitted testimony from Nancy Foley, a journalist from Massachusetts, concerning her fears and how that led her not to report her injury, as follows:

> ''In 1993, I began having pain in my neck and weakness in my hands. I did not seek medical attention until 1995 when the pain had spread into my left shoulder and left arm making it difficult for me to sit through the work day. Fear prevented me from seeking medical attention sooner. I was a part-time reporter. And I was afraid I would never be made full-time if my employer knew the job was injuring me (Tr. 7318–9).''

NIOSH also agrees that the BLS data underestimate the true magnitude of the occupational injury and illness problem for two reasons: (1) Approximately one-third of industries are not included in the BLS annual survey, and (2) underreporting of the true number of work-related health problems on the OSHA 200 Logs occurs. NIOSH stated that while it is widely accepted that occupational disease is underestimated in the U.S., the OSHA 200 Logs are the major data source used by BLS to determine the extent of occupational disease in the United States. OSHA is persuaded by the evidence in the record that work-related MSDs are currently being substantially underreported on OSHA Logs. OSHA believes that the number of lost-time, work-related MSDs quantified in the Agency's risk assessment on the basis of the BLS data is understated by at least a factor of two.

Other Evidence Risks are Significant

In addition to the BLS data, epidemiologic studies comparing the prevalence or incidence of MSDs in exposed populations with the prevalence or incidence in referent groups with lesser or no such exposure also document the elevated risk confronting employees exposed to workplace risk factors. These studies also identify the types of workplace risk factors associated with the development of work-related musculoskeletal disorders, as well as the duration of exposures found to be associated with these disorders. This information further supports the occupational origin of the reported disorders.

For example, the odds of having an upper extremity disorder like carpal tunnel syndrome or tendinitis/peritendinitis of the shoulder or wrist are 5–30 times greater among workers exposed to combinations of risk factors such as high force, repetition and awkward postures (*e.g.*, overhead work) then among either unexposed workers or workers who are exposed to a single risk factor (*e.g.*, Luopajarvi *et al.*, 1979, Ex. 26–56; Armstrong *et al.*,1987, Ex. 26–48; Silverstein *et al.*, 1987, Ex. 26–34; deKrom *et al.*, 1990, Ex. 26–41; Herberts *et al.*, 1984, Ex. 26–51). The odds of experiencing a low back disorder increased 3–8 fold among those workers exposed to frequent or forceful manual handling, awkward trunk postures (such as severe forward flexion), or to whole body vibration (Liles *et al.*, 1984, Ex. 26–33; Kelsey *et al.*, 1990, Ex. 26–52; Punnett *et al.*, 1991, Ex. 26–39; Wikstrom *et al.*, 1994, Ex. 26–61; Tanaka *et al.*, 1995, Ex. 26–59). Hip and knee disorders are associated with heavy physical work and awkward postures, such as kneeling and squatting, or using the knee as a kicker. Thun *et al.* (1987, Ex. 26–60) reported an increased risk of bursitis in carpet-layers that was 5 times higher than that of the unexposed workers. In a review of 4 studies, Hagberg and Wegman (1987, Ex. 26–32) estimated the work-attributable fraction of shoulder tendinitis in the exposed population to be 90%. In a review of 15 cross-sectional and 6 case control studies of carpal tunnel syndrome, Hagberg *et al.*(1992, Ex. 26–50) estimated the work-attributable fraction in the population exposed to high force, high repetition, vibration or awkward wrist/hand postures to be 50–90%. Olsen *et al.*(1994, Ex. 26–57) estimated that 40% of the cases of coxarthrosis (osteoarthrosis of the hip) seen in the exposed working population was due to heavy physical workload. Thus, in general, strong and consistent associations have been identified in the epidemiologic literature, primarily in cross-sectional and case control studies, but also in prospective studies (*e.g.,* Kurppa *et al.,* 1991, Ex. 26–53; Riihimaki *et al.,* 1994 Ex. 26–58; Felson *et al.,* 1991, Ex. 26–49). Exposure-response relationships have been identified in a number of studies, although precise quantitative modeling is not yet available.

Based on the various data and studies discussed in the Quantitative Risk Assessment and Health Effects sections of the preamble, OSHA finds that workers exposed to workplace risk factors are at significant risk of developing work-related musculoskeletal disorders, which are harmful and often disabling conditions. This is particularly true for workers who are exposed to a combination of risk factors over most of the workshift.

The data indicate that this rule would, if promulgated, cause employers to implement, for their problem jobs, interventions that would reduce the exposure of at-risk workers to workplace risk factors, and thus would substantially reduce significant risk. Specifically, the requirements to conduct job analyses and implement controls where exposure to risk factors is high (*i.e.,* for jobs meeting the Action Trigger and/or identified as having MSD hazards) would help to ensure that employees are exposed to fewer risk factors over time, or to a combination of risk factors for a lesser amount of time, than is now the case. A large body of data demonstrates that workplace interventions, such as job analysis to identify risk factors and implementation of controls to reduce exposures to these risk factors, can be very effective in reducing those forces responsible for musculoskeletal disease and injury; this has been shown in studies that have quantitatively examined the impact of ergonomic interventions on exposures to risk factors, as well as studies and reports that have documented actual reductions in injury prevalence following the implementation of ergonomics programs. Several of the standard's provisions, such as MSD management and training, will provide additional protection against the significant risk that will remain after controls are implemented in problem jobs.

C. OSHA's Response to Additional Comments

Several commenters argued that OSHA must quantify separately the risk posed by each hazard it is regulating (*i.e.,* force, awkward posture, vibration, repetition, and contact stress), and must do so in every industry below the two-digit SIC code level, in every occupational category, and in every job covered by the standard. See *e.g.*, Ex. 30–4499; Ex. 500–197; Ex. 500–187; 500–223.

In the Risk Assessment and Health Effects sections of this preamble, OSHA explained in detail its reasons for addressing these risk factors together in one standard. Substantial evidence in the rulemaking record demonstrates that these factors work together to pose a significant risk of material harm to employees. In most of the cohorts studied in the epidemiological literature examining these risk factors, the employees studied were exposed to combinations of the risk factors regulated; rarely would one of the risk factors be studied in isolation. In addition, substantial evidence in the rulemaking record indicates that ergonomic interventions are most effective when they examine an employee's exposure to all of the risk factors at issue at one time. The tools used to assess exposure to ergonomic risk factors are designed to account for interactions between risk factors. For example, the NIOSH lifting equation considers how forces applied by the worker (weight), the workers' posture, and lift frequency all interact to increase risk. Indeed, it would be inappropriate for OSHA to quantify the risk posed by each risk factor alone. Such an approach would not provide an accurate representation of the MSD hazard a particular employee faces when doing a certain job; indeed, such an approach would provide an inaccurate picture of the MSD hazards present. The OSH Act's requirement are met if OSHA determines that employees are being subjected to a significant risk of material impairment of health or functional capacity by the risk factors being targeted and that the standard being promulgated will reduce that risk substantially. OSHA has done that here.

Using the best available evidence, OSHA has found that employees are currently exposed to a significant risk of material harm from the risk factors of force, repetition, awkward posture, contact stress, and vibration. The BLS data used by OSHA to calculate significant risk included Nature of Exposure Event Codes corresponding to these risk factors:

- Repetitive motion: This category reflects the risk factor of repetition; however, such exposure is often combined with force and/or posture.
- Overexertion: This category reflects the risk factor of force; however, such exposure is often combined with repetition and/or posture.
- Bodily reaction: This category reflects the risk factor of posture; however, such exposure is often combined with force or repetition.

While the BLS data did not directly include numbers reflecting exposures to the risk factors of vibration and contact stress, OSHA believes that some of the MSDs included in the data may also have involved exposure to these hazards. Other evidence in the rulemaking record also convincingly shows that employees exposed to these two risk factors experience a significant risk of material harm. A number of epidemiological studies in the rulemaking record demonstrate that exposure to vibration at even low levels causes a number of serious conditions, including hand-arm vibration syndrome. See the discussion of vibration in the Health Effects section; see also Ex. 26–392. Indeed, NIOSH specifically found this in its 1997 review of the epidemiological literature. See Ex. 26–1. There is also substantial evidence in the rulemaking record that contact stress as defined by this standard can cause a significant risk of material harm. As discussed fully in the Health Effects section, the scientific literature strongly shows that contact stress causes such conditions as hypoththermal hammer syndrome and carpet layers' knee. Thus, there is no question that workers are currently exposed to a significant risk of material harm from the risk factors of force, repetition, vibration, awkward posture, and contact stress.

OSHA is also not required to conduct its significant risk analysis at a detailed industry level, or by occupational category or job. Where a standard requires employers to act only when the hazards being regulated are present in their workplace, OSHA has no duty to disaggregate risk in this manner. See *International Union, United Auto Workers* v. *OSHA* (LO/TO II), 37 F.3d 665, 670 (D.C. Cir. 1994). This was recently confirmed by the D.C. Circuit in its review of OSHA's Lockout/Tagout standard. In the Lockout/Tagout rulemaking, OSHA found that workers performing certain operations across general industry were exposed to a significant risk of material harm from the hazard of energy unexpectedly being released from certain powered industrial equipment. *Id.* at 667. Certain industry challengers argued that OSHA was under a duty to disaggregate the risk faced by workers by SIC code, particularly since, they contended, there was zero risk in certain SIC codes. The court held that the OSH Act placed no such duty on OSHA: ''If, as OSHA asserts * * * the regulation applies simply to *machines* that pose a significant risk and to workers subjected to that risk, we see no reason why OSHA should be concerned with industry classifications that appear essentially irrelevant to its task.'' *LO/TO II,* 37 F.3d at 670 (emphasis added). *See also Associated Builders and Contractors, Inc.* v. *OSHA*, 862 F.2d 63, 68 (3d Cir. 1988) (''A requirement that the Secretary assess risk to workers and need for disclosure with respect to each substance in each industry would effectively cripple OSHA's performance of the duty imposed on it * * *''); *American Dental Ass'n* v. *Martin*, 984 F.2d 823, 827 (7th Cir. 1993) (''[T]he agency [is not] required to proceed workplace by workplace, which in the case of bloodborne pathogens would require it to promulgate hundreds of thousands of separate rules.'').

Like OSHA's Lockout/Tagout rule, this standard is not ''industry-based.'' An employer is required to respond to an employee report of signs or symptoms of an MSD only when the employer determines that an ''MSD incident'' has occurred and the employee's job is one that contains risk factors that exceed the standard's screen. OSHA is not triggering industry wide obligations; rather, it is triggering obligations on employers where there are ergonomic hazards present at certain levels in jobs in their workplace. Under these circumstances OSHA is not required to disaggregate risk by three or four digit SIC code, or by occupational category, or by jobs potentially covered by the standard.

Several commenters argued that because MSDs are not fatal, OSHA should deviate from its past practice of considering as ''significant'' a ''one in a thousand'' risk that a worker will develop an MSD over a working lifetime. See *e.g.*, Ex. 500–223.

As noted above, a plurality of the Supreme Court in Benzene held that, although ''it is OSHA's responsibility to determine, in the first instance, what it considers to be a ''significant'' risk, * * * the requirement that a ''significant'' risk be identified is not a mathematical straitjacket * * * [and] the Agency has no duty to calculate the exact probability of harm.'' *Id.* at 655. While the Court noted OSHA's broad discretion to formulate what level of risk it considers to be significant, the Court also provided guidance to OSHA as to what a reasonable person might consider a significant risk of material harm:

> ''Some risks are plainly acceptable and others are plainly unacceptable. If, for example, the odds are one in a billion that a person will die from cancer by taking a drink of chlorinated water, the risk clearly could not be considered significant. On the other hand, if the odds are one in a thousand that regular inhalation of gasoline vapors that are 2 percent benzene will be fatal, a reasonable person might well consider the risk significant and take the appropriate steps to decrease or eliminate it.'' *Id.* at 655.

In past standards, OSHA has applied that guidance, noting that a risk of one in a thousand of dying from an occupational exposure is significant. However, OSHA has never quantified the lowest level of risk of death that it considers significant, beyond acknowledging that the level must be higher than one in a billion. Thus it is not true that OSHA takes the position that a risk of dying is necessarily insignificant if it is less than one in a thousand.

OSHA has only infrequently quantified the risks of nonlethal harm from workplace exposures. It recognizes, however, that a reasonable person might well be willing to accept a greater risk of injury than of death, and that there may be cases where even a risk of one in a thousand of some types of injuries occurring is insignificant. OSHA need not determine whether this is such a case, however, because, throughout general industry, the working lifetime risk of developing an MSD is extraordinarily high. OSHA has found working lifetime risks to be as high as 835 per thousand (Transportation by air), 486 per thousand (Local and suburban transit and interurban highway passenger transportation), and 206 per thousand (Real estate). Even in SIC code 62 (Security and Commodity Brokers, Dealers, Exchanges, and Services), the SIC code with the lowest risk, 24 out of 1,000 workers are likely to suffer at least one MSD during a working lifetime. These risk levels are extremely high by any measure or formulation and are clearly ''significant'' under the OSH Act. Further, the serious and often disabling nature of these disorders is attested to by the fact that their severity (measured by median number of days away) is greater than median for all other injuries and illnesses combined.

Some commenters argued that the standard is improperly structured to reduce all risk, even insignificant risk. See Exs. 30–4185; 30–3951. OSHA agrees that this standard will substantially reduce the significant risk of material harm faced by workers from exposure to ergonomic risk factors. OSHA estimates that the standard will reduce the number of lost workday MSDs currently reported to the BLS by approximately 50%. This amounts to approximately 300,000 MSDs a year and constitutes a substantial reduction in the number of MSDs experienced by workers every year across general industry. This standard is not designed to reduce ''insignificant'' risk, however. OSHA has made some changes to the standard (from the proposed rule) to ensure that employers are not required to act when the risk posed to their employees from the risk factors at issue is below certain levels.

First, OSHA has included a screen in the standard that will ensure that employers are not required to act in the absence of ''significant risk.'' OSHA established the screen based on substantial evidence in the rulemaking record showing substantial excess risk of developing MSDs above the hazard levels in the screen. If employees are exposed to the risk factors at issue below the levels indicated by the screen, employers have no obligations to analyze their jobs, implement controls, or train their workers.

Second, OSHA has not included the proposed incremental abatement process in the final standard. As explained more thoroughly in section IV, above, the incremental abatement process would have allowed employers to incrementally implement controls to certain jobs to materially reduce MSD hazards. If continued exposure to certain hazards in the job prevented an injured employee from recovering, the employer was required to implement additional feasible controls. Although this approach mirrored what many employers were currently doing in their ergonomics programs, it was highly criticized during the rulemaking process. One criticism was that it effectively required employers to continue to implement controls when the risk posed by a certain job was no longer ''significant.'' Although OSHA does not agree that the process placed requirements on employers to act where there was no significant risk, OSHA has nonetheless eliminated the requirement from the final standard in order to, among other tings, avoid any implication that employers must abate hazards that are not significant.

Some commenters argued that OSHA improperly relied on the BLS data for its significant risk analysis because the data include injuries and illnesses that are only 1% caused by work. See Ex. 32–78. These commenters miss the point about OSHA's significant risk analysis. The appropriate question to be asked is whether the BLS data accurately reflect the risk faced by workers exposed to the risk factors being regulated and whether the standard will substantially reduce that risk. As explained above, the BLS data represent the best available evidence on the magnitude of the MSD problem in the United States today, and thus on the significant risk faced by workers from exposure to the ergonomic risk factors at issue. The BLS survey is a comprehensive one; it collects workplace injury and illness data from about 165,000 private industry establishments. For the survey, selected employers are required to provide statistics on the total number of injuries and illnesses recorded on the OSHA Form 200, as well as information describing the nature and causes of their lost workday injuries and illnesses. The information is provided in sufficient detail to permit BLS to systematically code each reported case and develop estimates of the numbers and incidence of each specific type of LWD injury and illness for the United States as a whole, by industry sector and by occupation. The data provided reflect the employer's understanding of which cases are work-related under current U.S. Department of Labor recordkeeping guidelines. OSHA is thus confident that the reported cases of MSDs included in the significant risk analysis accurately reflect injuries caused by work.

OSHA has also taken a number of additional steps to ensure that the risk assessment and the significant risk analysis have a tight nexus with the risk factors being regulated and the structure of the standard. As stated, OSHA only included Nature of Exposure Event categories in its risk assessment that corresponded to the risk factors targeted by the standard. Thus, the MSDs experienced by workers as a result of exposure to risks not covered by this standard are not included in the Risk Assessment. In addition, for the final standard OSHA has conducted a second, alternative analysis that eliminated from the risk assessment MSDs caused by exposure to risk factors at levels below the screen. See Risk Assessment discussion. This additional analysis confirms OSHA's conclusions as to the risk faced by workers exposed to the risk factors at issue and demonstrates that the risk of developing MSDs for workers exposed to risk factors at levels meeting the screen is alarmingly high and, without question, significant.

One commenter argued that OSHA has improperly considered ''significant'' risks that represent incident rates much lower than those being targeted in the Agency's new enforcement plan. Tr. 10439 (NCR Corporation). The OSH Act and past OSHA practice provide the framework within which OSHA must make its significant risk finding. Acting within this framework and on the best available evidence, OSHA has found that a significant risk of material harm currently exists for workers exposed to the hazards regulated and that the standard will substantially reduce that risk. OSHA's enforcement strategy, on the other hand, is based on entirely different principles. Because OSHA has a limited enforcement budget, OSHA targets its enforcement activities to industries where the risk of harm is particularly severe. OSHA engages in comprehensive data collection in order to determine where certain industries fall within this prioritization scheme. OSHA's most recent enforcement initiative focuses on relatively large workplaces whose past experience shows that hazards are likely to be present. The principles used to support OSHA's enforcement efforts are very different from the principles OSHA must abide by in setting occupational safety and health standards. For this reason, it is entirely appropriate for OSHA to apply different standards for determining significant risk and targeting its enforcement activities.

D. Conclusions

OSHA concludes, based on the evidence discussed above and elsewhere in the record, that the scientific data are sufficient to demonstrate that exposure to work-related risk factors is associated with the development of musculoskeletal disorders of the upper extremities, back, and lower extremities. Risk factors identified from this body of literature include repetitive motions; use of excessive force; segmental vibration; maintaining awkward postures of the neck, wrists, arms, trunk, and lower-extremities; and lifting, lowering, pushing, carrying, and pulling loads of excessive weight. Depending on the specific combinations of risk factors encountered in the workplace, musculoskeletal disorders identified as being work-related include carpal tunnel syndrome (hand, wrist), trigger finger (hand), De Quervains' disease (wrist), tendinitis (hand, wrist, shoulder, ankle), epicondylitis (elbow), rotator cuff tendinitis (shoulder and neck), sciatica (lower back), osteoarthritis (hip, knee), bursitis (knee), and tarsal tunnel syndrome (foot).

The evidentiary base on which OSHA relies in making these conclusions is described fully in the Health Effects section of the preamble. This evidence is comprised of several hundred cross-sectional, case-control, prospective, and case series reports of working populations in a variety of industrial settings. Supplementing these reports is a large body of scientific literature that provides data on the mechanisms by which exposure to these risk factors causes musculoskeletal disorders; these data demonstrate the biological plausibility of the relationship between exposure to workplace risk factors and an elevated risk of MSD injury and illness.

MSDs have been recognized as compensable under virtually all State workers' compensation plans, demonstrating that exposure to work-related risk factors is already widely recognized as a cause of musculoskeletal disorders. Taken together, OSHA believes that the scientific and other evidence described in the preamble to this rule constitute an evidentiary base of unusual depth and quality.

Accordingly, OSHA concludes that musculoskeletal disorders associated with workplace exposure to workplace risk factors constitute material harm under the OSH Act. Further, as demonstrated by the evidence discussed in Section B above, the data available to the Agency demonstrate clearly that workers in the occupations and industries covered by the ergonomics program standard are at significant risk of experiencing a work-related MSD over their working lifetime; for many occupations and industries, they are at significant risk of experiencing a work-related MSD even in a single year of work in their job.

VIII. Summary of the Final Economic Analysis and Regulatory Flexibility Analysis

A. Introduction

OSHA's Final Economic and Regulatory Flexibility Analysis (Ex. 900) addresses issues related to the costs, benefits, technological and economic feasibility, and economic impacts (including small business impacts) of the Agency's ergonomics program rule. The analysis also evaluates regulatory and non-regulatory alternatives to this rule.

This rule is a significant rule under Executive Order 12866 and has been reviewed by the Office of Information and Regulatory Affairs in the Office of Management and Budget, as required by the executive order. In addition, this economic analysis meets the requirements of both Executive Order 12866 and the Regulatory Flexibility Act (as amended in 1996). The complete Final Economic and Regulatory Flexibility Analysis has been entered into the rulemaking docket as Ex. 900. This Final Economic and Regulatory Flexibility Analysis presents OSHA's full economic analysis and methodology, as well as responses to comments in the record on the Preliminary Economic and Regulatory Flexibility Analysis. The remainder of this section of the Preamble summarizes the results of that analysis.

The purpose of this Final Economic and Regulatory Flexibility Analysis is to:

• Identify the establishments and industries potentially affected by the rule;

• Estimate the benefits of the rule in terms of the reduction in musculoskeletal disorders (MSDs) employers will achieve by coming into compliance with the ergonomics program standard and some of the direct cost savings associated with those reductions;

• Evaluate the costs, economic impacts and small business impacts establishments in the regulated community will incur to establish ergonomics programs to achieve compliance with the standard;

• Assess the economic feasibility of the rule for affected industries;

• Evaluate the principal regulatory and non-regulatory alternatives to the final rule that OSHA has considered;

• Present the Final Regulatory Flexibility analysis for the ergonomics program rule; and

• Respond to the findings and recommendations made to OSHA by the Small Business Regulatory Enforcement Fairness Act (SBREFA) Panel convened for this standard.

The Final Economic Analysis contains the following chapters:

Chapter I, Introduction
Chapter II, Industrial Profile
Chapter III, Technological Feasibility
Chapter IV, Benefits
Chapter V, Costs of Compliance
Chapter VI, Economic Feasibility
Chapter VII, Economic Impacts and Final Regulatory Flexibility Analysis
Chapter VIII, Assessment of Non-Regulatory Alternatives.

B. Introduction and Industrial Profile (Chapters I and II)

Data from the Bureau of Labor Statistics (BLS) *Annual Survey of Occupational Injuries and Illnesses* for 1996 shows that 626,000 U.S. workers across all industries experienced musculoskeletal disorders serious enough to require time away from work for recuperation in that year (Ex. 26–1413). In addition to these lost workday MSDs, OSHA estimates that, on average across all of general industry, about two times as many non-lost workday cases involving work-related MSDs occur every year in U.S. workplaces.

In some general industry sectors, lost workday MSD rates reached 37 cases per 1,000 full-time equivalent (FTE) workers in 1996, and in many others, annual incidence rates were greater than 10 per 1,000 FTE (Ex. 26–1413). If these annual risks are converted into working lifetime risks (assuming a 45-year working lifetime), the risks of experiencing a lost workday MSD faced by general industry employees over the course of their working life, based on OSHA's most conservative estimates, range from 24 to 813 per 1,000 workers, depending on the particular industry in which the worker is employed (see the Significance of Risk section of this preamble). By any reasonable definition, these risks of material impairment are significant. Another indicator of the significance of work-related MSDs to the economy is the fact that employers annually pay out, in direct workers' compensation costs, between $15–$18 billion, or about 1 dollar of every 3 workers' compensation dollars, for MSD-related claims.

The extensive evidence available clearly demonstrates that ergonomic risk factors—such as repetitive motion, force, awkward posture, and vibration—are present in all types of general industry workplaces, including small, medium, and large workplaces. In today's workplace, the pace of work, the specialization of work, and continued reliance on unassisted manual handling require many workers to apply excessive force, perform too many lifts and carries, and repeat similar motions too often. Many studies cited in the Health Effects section of the preamble (Section V) to the final standard demonstrate the presence of these risk factors in the workplace, and many biomechanical studies show the effects on the soft tissues of the body of these external forces: tissue damage, pathophysiology, and outright disease.

Market mechanisms have been inadequate to address these risks (see the discussion in Chapter VIII of this economic analysis). Although many firms, and particularly larger firms, have addressed ergonomic risk factors and substantially reduced their MSD rates, many firms have not. Approximately 60 percent of all general industry employees continue to work in establishments that have not yet addressed ergonomic risk factors, despite the widespread presence of MSD hazards.

Because these characteristics of work are not unique to the United States, countries of every size and on every continent are also experiencing significant numbers of musculoskeletal disorders among their workforces. Many of these countries—ranging from the United Kingdom and Sweden to Pakistan, Ecuador, and South Africa—have already established regulatory requirements designed to address some or all of the workplace risk factors giving rise to these disorders. A table summarizing the ergonomics rules and guidelines issued by other countries and organizations can be found in Chapter I of this Final Economic Analysis.

The standard OSHA is issuing today applies to general industry employers and will also affect state and local government entities or agencies in OSHA's State-plan States, except that the following industries are exempt from the scope of the final standard: agriculture; maritime; and construction. In addition, the standard does not apply to railroad operations.

The final ergonomics rule is a program standard, *i.e.,* one that requires employers whose employees experience MSDs in jobs determined to be higher risk jobs to implement a program that includes the elements of any sound safety and health (ergonomics) program. These include management leadership and employee participation, job hazard analysis to identify musculoskeletal hazards, the implementation of controls to reduce the hazards identified, training for employees and their supervisors or team leaders in jobs that have MSD hazards, management of musculoskeletal disorders when they occur, and regular evaluation of the program to ensure that it is functioning as intended.

The final rule contains many features that act to target the standard to the most hazardous jobs; to limit the compliance obligations of employers as much as possible, consistent with employee protection; and to permit employers to adapt the required program and its elements to the conditions and circumstances of their particular workplaces. Among the standard's flexible provisions are the following:

- The programmatic design of the standard itself, which requires employers to establish a basic framework with widely agreed-upon elements but leaves employers free to provide many of the establishment-specific details;
- A two-step action trigger, which requires the employer to take action only if an employee has experienced an MSD incident (one involving medical treatment beyond first aid, days away from work or on restricted work, or signs or symptoms lasting 7 days or longer) and that employee's job is determined to involve heightened exposure to ergonomic risk factors;
- A Quick Fix provision, which allows employers whose employees have experienced only a few MSDs to fix the problem job without having to implement the entire program;
- Provisions that specify that the employer is only required to implement a program for those jobs meet the action trigger, and then only to implement the program in that establishment;
- A provision permitting employers to use a variety of methods to conduct job hazard analysis;
- A provision permitting employers to demonstrate that they have met their hazard control obligations in any one of a variety of ways;
- A ''grandfather'' clause that permits employers with effective existing programs that contain the basic elements of ergonomics programs and that have been evaluated and shown to be effective before the standard's effective date to continue to implement their programs rather than the program required by the standard;
- Provisions stating that an employer's obligation to maintain its ergonomics program ceases for employees and jobs once the job has been controlled to levels below the screen.

OSHA believes that the flexibility afforded by the final rule will facilitate compliance by employers of all sizes and provide their employees with the protections they need against the ergonomic hazards that are so prevalent in general industry workplaces today.

The standard being issued today depends heavily on employee reporting for its effectiveness. This is the case because a report of an MSD or MSD signs and symptoms is the trigger to further action by the employer. Once an employee has reported an MSD, or its signs or symptoms, to the employer, the employer must determine whether the MSD (or signs or symptoms) meet the standard's definition of an MSD incident. An MSD incident is defined by the standard as a work-related MSD or MSD sign or symptom that involves persistent signs or symptoms (those lasting for 7 or more consecutive days since the time they were reported to the employer), or that requires medical treatment beyond first aid, one or more days of restricted work, or one or more days away from work. If the employee's report of an MSD is determined by the employer to be an MSD incident, the employer must then move to the second prong of the standard's action trigger: a review of the employee's job to determine whether it involves ergonomic risk factors (repetition, force, vibration, awkward postures, or contact stress) for durations that meet those specified by the Basic Screening Tool in Table 1 of the standard for that risk factor. If the relevant risk factors in the employee's job do not meet the screen in Table 1, the employer is not required to take further action. In other words, unless both parts of the action trigger are met (the occurrence of an MSD incident *and* the presence, in that employee's job, of risk factor(s) meeting the screen), *no* ergonomics program is triggered.

OSHA believes that the action trigger in the final rule is a highly effective targeting device because OSHA's data show that only about 37 percent of all general industry jobs will meet the screen, but that about two-thirds of all lost workday MSDs reported to the BLS annually occur in those jobs. Put another way, the risk that an employee will incur an MSD is about three times greater in a job with risk factors that meet the screen than in jobs that do not have such risk factors.

The standard requires employers who have jobs that meet the action trigger to implement an ergonomics program for that job and for all employees in the same job within the establishment.[1] The program consists of the following elements: management leadership, employee participation, job hazard analysis, employee training, MSD management (called medical management by many employers) and if a hazard is found—hazard control and program evaluation.

The final rule provides employers with several different hazard identification tools that they may use to determine whether a job that meets the screen does in fact pose an MSD hazard to employees in that job. These tools appear in two appendices (Appendices D–1 and D–2) to the standard. OSHA believes that a number of jobs that meet the screen will subsequently be shown, by a job hazard analysis, not to present a hazard to employees. For example, some jobs will have an ergonomic risk factor, or a combination of risk factors, at levels that meet the screen; however, use of one of the hazard identification tools in Appendix D, such as the Rapid Upper Limb Assessment (RULA), may show that the risk factors present in the job are within the ''acceptable'' zone on that tool.

The final rule permits employers to use a variety of hazard identification tools, which are included in appendices to the standard. Employers may also choose to rely for hazard identification on the services of a safety and health professional trained and experienced in ergonomics; in addition, they may choose to use any other reasonable method that is appropriate to the job and addresses the relevant risk factors. If the job hazard analysis identifies MSD hazards in the injured employee's job, the employer must then identify and implement controls to reduce these hazards.

The standard also permits employers great flexibility in meeting their obligations to control MSD hazards in jobs that have been identified as posing MSD hazards to employees. Employers may fulfill their obligations by:

- Controlling MSD hazards (defined as reducing the hazards to the extent they are no longer reasonably likely to cause MSDs that result in work restrictions, or medical treatment beyond first aid); or
- Reducing MSD hazards in accordance with or to the levels indicated by one of the hazard identification tools used by the employer in the job hazard analysis; or
- Reducing MSD hazards to the extent feasible.

Employers who control their problem jobs to one of these ''endpoints'' will be considered to be in compliance with the standard's hazard control requirements. OSHA believes that the range of control obligation endpoints permitted by the standard will ensure that employers will

[1] Employers qualifying for and choosing to use the Quick Fix provision of the standard do not have to implement a program but may instead implement controls and follow other procedures to address the risk factors in that job alone.

be able to control all of their problem jobs.

Employers are also permitted by the standard to use any combination of engineering, work practice, and administrative controls to meet their control obligations, although personal protective equipment may only be used alone when other kinds of controls are not feasible.

The standard's requirements for MSD management mandate that employers provide employees who have experienced an MSD incident in a job meeting the action trigger with: access to a health care professional; any work restriction or removal from work deemed to be necessary to allow the injured body part to recover; and the evaluation, management, and follow-up of the MSD needed to facilitate the employee's recovery. In addition, employers are required to maintain 100 percent of the wages, benefits, and employment rights of employees placed on restricted work to recover from an MSD, and they must maintain 90% of the wages, and all benefits and employment rights, of employees removed from work to recover. These protections, termed ''work restriction protections'' (WRP) by the standard, must be maintained until the *first* of the following occurs:

- An HCP determines that the employee can never return to the former job;
- The employee is able to return to the former job without endangering his or her recovery; or
- Ninety calendar days have passed.

As discussed at length in the summary and explanation for paragraph (r), OSHA has concluded that work restriction protections are required to encourage employees to come forward to report their signs and symptoms and to participate in the employer's MSD management program.

The standard also requires employees in problem jobs to be trained, initially and periodically, in the employer's ergonomics program and their role in it; the MSD hazards present in their jobs; the employer's plan for controlling these hazards; the use of these controls; and ways of evaluating the effectiveness of the controls selected. The training must be provided in language that the employee understands.

Employers must also evaluate their ergonomics programs, or the relevant part of their program, when they believe that the program or one of its elements is not functioning properly or that operations in the workplace have changed in a way that may increase employee exposure to ergonomic risk factors. In addition, program evaluations must be conducted every three years, at a minimum.

The standard requires employers with 11 or more employees to maintain records of: Employee reports of MSDs and MSD hazards (including employer's response to such reports), Job hazard analyses, Controls implemented, Quick fixes, Program evaluations, and Work restrictions and HCP written opinions. Required records must be accessible to employees and their designated representatives.

The standard provides a series of extended compliance phase-in dates for the various provisions of the standard. These range from 9 months to 4 years, depending on the particular provision.

Table VIII–1, based on data from *County Business Patterns* for 1996, shows the three-digit industries covered by the standard and the number of employees and establishments in each covered industry within the general industry sector (Ex. 28–2). Table VIII–1 also shows the estimated annual incidence rates for all MSDs (lost workday, restricted work, and non-lost workday) for each industry. These estimates do not include the number of MSDs currently underreported that OSHA believes will be reported once the standard is in effect or the number of reports of MSD signs and symptoms that will qualify under the final rule as MSD incidents. Together, these two kinds of MSDs increase the number of MSDs shown on Table VIII–1 by 50 percent. These rates differ from those shown in the risk assessment section of the Preamble because they include an estimate of all MSDs, rather than lost workday MSDs only, and because they use *County Business Patterns* estimates of industry employment in computing MSD rates. Table VIII–1 shows that the total MSD incidence rates in general industry range as high as 1,448 per 10,000 workers (in Public building and related furniture (SIC 253)). A total of about 6.1 million establishments and 102 million employees are present in general industry including state and local government.

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Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSDs, by 3-Digit SIC

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate* (per 10,000 workers)
074	Veterinary services	22,807	174,576	112
075	Animal serv., excpt vet.	10,369	42,832	71
078	Lndscape & hort. services	68,157	345,871	268
081	Timber tracts	862	7,025	202
083	Forest products	137	2,082	234
085	Forestry services	1,568	12,265	135
091	Commerical fishing	1,947	8,850	167
092	Fish hatcheries	95	1,465	167
097	Hunting & trapping	339	1,650	172
131	Crude petrol. & nat. gas	7,758	83,909	74
132	Natural gas liquids	560	12,814	110
138	Oil & gas field services	8,764	159,639	152
201	Meat products	3,080	458,861	761
202	Dairy products	1,881	134,051	496
203	Presrvd fruits & vegetables	2,016	183,797	410
204	Grain mill products	2,603	109,406	520
205	Bakery products	3,523	230,724	402
206	Sugar and confect. prods	1,098	86,710	357
207	Fats and oils	507	26,512	311
208	Beverages	2,286	144,328	703
209	Misc. food products	4,007	165,889	453
211	Cigarettes	15	20,498	319
212	Cigars	47	2,737	119
213	Chewing & smoking tobacco	26	2,479	288
214	Tobacco stemm. & redrying	32	5,055	331
221	Brdwven fab. mills, cotton	412	50,459	844
222	Broadwoven fabric mills	458	79,013	257
223	Brdwvn fab. mills, wool	99	13,628	224
224	Narrow fabric mills	277	17,608	558
225	Knitting mills	1,945	177,354	355
226	Tex. finishing, excpt wool	852	53,437	372
227	Carpets and rugs	484	52,137	246
228	Yarn and thread mills	588	82,102	322
229	Misc. textile goods	1,010	54,492	329
231	Men's & boys' suits & coats	293	30,229	338
232	Men's & boys' furnishings	2,112	211,208	455
233	Wm's & misses' outerwear	8,954	249,317	206
234	Wm's & chldrn's undergarmnts	372	35,283	365
235	Hats, caps, & millinery	381	18,675	273
236	Girls' & chldrn's outerwear	585	36,315	233
237	Fur goods	133	550	273
238	Misc. apparel & accessories	933	30,771	317
239	Misc. fab. textile prods	8,797	220,100	310
241	Logging	14,273	86,675	67
242	Sawmills & planing mills	6,103	167,103	401
243	Millwork & plywood	9,548	254,660	553
244	Wood containers	2,830	48,027	401
245	Wood bldings & mobile homes	1,044	82,857	678
249	Misc. wood products	3,536	91,967	367
251	Household furniture	5,500	263,791	460
252	Office furniture	1,033	70,867	509

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSDs, by 3-Digit SIC

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate* (per 10,000 workers)
253	Pub blding & related furn.	449	34,886	1448
254	Partitions and fixtures	2,996	80,751	507
259	Misc furniture and fixtures	1,412	45,588	319
261	Pulp mills	62	15,349	138
262	Paper mills	344	121,373	360
263	Paperboard mills	228	54,165	155
265	Paperbrd containers & boxes	2,809	206,643	327
267	Misc. cnvrtd paper products	3,033	227,539	303
271	Newspapers	8,878	395,716	196
272	Periodicals	5,781	117,880	117
273	Books	3,559	135,942	206
274	Miscellaneous publishing	3,259	61,716	122
275	Commercial printing	34,435	587,534	226
276	Manifold business forms	911	45,341	359
277	Greeting cards	143	19,958	434
278	Blankbooks & bookbinding	1,583	63,356	317
279	Printing trade services	3,436	56,387	113
281	Indust. inorganic chemicals	1,390	85,705	163
282	Plastics mat. & synthetics	876	117,868	163
283	Drugs	1,637	207,295	193
284	Soap, clnrs, & toilet goods	2,434	120,815	237
285	Paints & allied products	1,479	52,183	264
286	Indust. organic chemicals	946	121,918	120
287	Agricultural chemicals	938	40,431	152
289	Misc. chemical products	2,566	86,431	263
291	Petroleum refining	275	70,045	107
295	Asphlt pavng & roofng mat.	1,368	24,390	294
299	Misc. pet. & coal prods	466	13,874	101
301	Tires and inner tubes	171	65,902	686
302	Rubber & plastics footwear	61	8,895	724
305	Hose, bltng, and gaskets	826	59,475	578
306	Fab. rubber prod., n.e.c.	1,767	111,074	574
308	Misc plastics, n.e.c.	13,648	751,503	420
311	Leather tan. & finishing	343	14,843	552
313	Footwear cut stock	70	2,103	347
314	Footwear, except rubber	378	38,768	480
315	Leather gloves & mittens	69	2,349	753
316	Luggage	261	10,231	229
317	Hndbags & prsnal leathr gds.	343	9,382	385
319	Leather goods, n.e.c.	418	8,414	580
321	Flat glass	81	13,203	749
322	Glass, pressed or blown	589	61,911	562
323	Prod. of purchased glass	1,640	61,300	507
324	Cement, hydraulic	231	16,283	311
325	Structural clay products	593	29,093	532
326	Pottery & related prods	1,200	39,441	625
327	Concrete & plast. prdcts	9,498	190,188	360
328	Cut stone & stone prods	1,071	13,867	397
329	Misc. nonmet. mineral prods.	1,599	69,785	411
331	Basic steel products	1,284	225,373	438
332	Iron and steel foundries	1,160	133,111	794

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSDs, by 3-Digit SIC

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate* (per 10,000 workers)
333	Primary nonfer. metals	201	34,534	444
334	Secondary nonfer. metals	299	15,013	543
335	Nonfer. rolling & drawing	1,105	153,482	503
336	Nonfer. foundries (cstngs)	1,662	89,402	629
339	Misc. primary metal prdcts	947	31,444	231
341	Met. cans & ship. containers	435	35,214	431
342	Cutlery, hndtls, & hardware	2,446	133,392	476
343	Plumbing & heating fixtures	688	46,295	920
344	Fab. struct. metal prdcts	13,334	428,117	450
345	Screw machine products	2,602	99,345	491
346	Met. forgings & stampings	3,694	258,010	704
347	Metal services, n.e.c.	5,529	124,099	383
348	Ordnance and access., n.e.c.	438	39,859	339
349	Misc. fab. metal products	7,266	296,592	452
351	Engines and turbines	371	75,184	561
352	Farm & garden machinery	1,761	98,072	501
353	Construct. & related mach.	3,324	195,304	508
354	Metalworking machinery	11,811	295,152	376
355	Special industry mach.	4,790	190,365	348
356	General indust. mach.	4,378	260,600	413
357	Computer & office equip.	2,112	227,720	213
358	Refrig. & serv. indust mach.	2,246	199,595	566
359	Industrial mach., n.e.c.	25,875	377,370	304
361	Elect. dist. equipment	875	68,623	369
362	Elect. indust. apparatus	2,260	162,510	440
363	Household appliances	474	106,685	677
364	Elct. lghtng & wire equip.	2,117	154,073	474
365	Household audio & vid. equip.	815	50,938	408
366	Communications equipment	2,110	254,639	170
367	Electrnic compnnts & access.	6,570	594,638	196
369	Misc. elect. equipment	1,788	152,482	499
371	Motor vehicles & equipt.	5,049	785,168	1221
372	Aircraft and parts	1,693	400,899	358
373	Ship, boat blding and repair	2,676	52,904	630
374	Railroad equipment	213	35,344	630
375	Motorcycles & bicycles	370	16,400	615
376	Guided missiles	105	78,710	141
379	Misc. transportation equip.	1,135	53,849	569
381	Srch & navigation equipment	696	184,871	124
382	Meas. & contrlling devices	4,755	265,806	257
384	Medical instrmnts & supplies	4,471	267,624	221
385	Ophthalmic goods	587	26,417	312
386	Photo. equip. & supplies	721	62,716	377
387	Watches, clocks, & parts	141	5,765	144
391	Jwlry, slvrwre, and plate	2,813	45,819	236
393	Musical instruments	550	13,562	549
394	Toys and sporting goods	3,515	106,609	534
395	Office and art supplies	1,038	28,540	233
396	Costume jewelry & notions	1,092	22,970	189
399	Misc. manufactures	8,803	171,667	338
411	Local & suburban trans.	9,536	194,756	419

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSDs, by 3-Digit SIC

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate* (per 10,000 workers)
412	Taxicabs	3,304	27,944	67
413	Intercty & rural bus trans.	481	20,621	292
414	Bus charter service	1,432	29,190	97
415	School buses	4,248	143,919	81
417	Bus terminals	57	477	509
421	Trking & Courier Service	116,861	1,725,748	257
422	Pub. warehousing & storage	11,856	121,344	441
423	Trucking terminal fac.	80	766	501
430	United States Postal Service	33,316	904,636	325
451	Air trans., scheduled	6,608	621,649	1171
452	Air trans., nonsched.	1,831	28,845	175
458	Airports and services	4,014	104,581	322
461	Pipelines, excpt natural gas	963	15,065	446
472	Pass. trans. arrangements	33,106	223,624	27
473	Freight trans. arrangements	14,771	137,522	148
474	Rental of railroad cars	116	2,326	113
478	Misc. trans. services	2,681	42,104	269
481	Telephone communication	27,277	927,967	101
482	Telegrph & other comm.	466	5,782	75
483	Radio & TV broadcasting	8,833	238,078	36
484	Cable & othr pay TV services	4,786	170,300	172
489	Communication serv., n.e.c.	1,488	22,405	45
491	Electric services	6,278	382,861	187
492	Gas product. & distribution	3,941	135,670	219
493	Comb. utility services	1,871	199,685	125
494	Water supply	3,701	26,045	227
495	Sanitary services	6,491	130,347	532
496	Steam & air-cond. supplies	69	1,400	225
497	Irrigation systems	366	1,785	225
501	Motor vehicles	45,779	520,711	218
502	Furn. & homefurnishings	16,693	169,720	249
503	Lumber & construct. mat.	23,678	264,739	411
504	Prof. & commercial equip.	51,941	725,137	139
505	Met. & minerals, excpt pet.	11,416	154,821	296
506	Electrical goods	41,707	508,202	156
507	Hardware supplies	26,119	269,607	303
508	Mach., equipt, & supplies	76,249	762,397	223
509	Misc. durable goods	40,029	354,068	190
511	Paper and paper products	18,712	291,514	129
512	Drugs, propriet., & sundries	7,316	173,960	147
513	Apparel and notions	21,766	209,032	145
514	Groceries & related products	43,314	846,803	387
515	Farm-prod. raw materials	10,680	98,112	82
516	Chemicals & allied prods	15,171	163,603	152
517	Petrol. & petrol. prods	13,177	153,471	161
518	Beer, wine, & dist. bev.	5,055	148,567	553
519	Misc. nondurable goods	54,335	505,832	208
521	Paint, glass, wallpaper strs	24,266	475,454	401
523	Hardware stores	9,777	49,415	315
525	Retail nurseries and gardens	14,282	124,402	215
526	Mobile home dealers	11,258	80,822	254

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSDs, by 3-Digit SIC

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate* (per 10,000 workers)
527	Department stores	4,780	36,746	371
531	Variety stores	10,824	1,850,213	378
533	Misc. gen. merchandise strs.	10,848	92,765	513
539	Grocery stores	14,797	316,419	139
541	Meat and fish markets	129,150	2,980,869	254
542	Fruit & vegetable markets	7,868	45,979	183
543	Candy, nut, & confctnry strs	3,342	19,178	106
544	Dairy products stores	4,742	27,794	91
545	Retail bakeries	2,550	14,746	68
546	Retail bakeries	20,156	148,069	120
549	Misc. food stores	9,904	55,450	89
551	New and used car dealers	24,639	1,014,799	200
552	Used car dealers	21,951	85,892	28
553	Auto & home supply stores	43,806	345,849	212
554	Gas service stations	96,236	713,280	110
555	Boat dealers	5,068	33,121	220
556	Rec. vehicle dealers	2,995	28,499	300
557	Motorcycle dealers	3,785	29,387	20
559	Auto dealers, n.e.c.	1,234	5,654	28
561	Men's & boys' clothing strs	13,844	92,334	67
562	Women's clothing stores	40,559	327,351	40
563	Wm's access.& specialty strs	8,647	50,147	41
564	Chldrn's & infants' wear strs	5,186	45,078	53
565	Family clothing stores	19,583	329,123	165
566	Shoe stores	31,737	180,967	67
569	Misc. apparel stores	10,161	53,173	31
571	Furnitre & homefurnishng strs	66,004	475,508	260
572	Household appliance strs	10,045	63,989	239
573	Radio, TV, & comptr strs	39,074	336,182	105
581	Eating & drinking places	466,386	7,416,595	79
591	Drug stores	43,221	588,160	75
592	Liquor stores	28,812	128,995	32
593	Used merchandise stores	23,524	117,116	127
594	Misc. shopping goods strs.	129,136	850,337	107
596	Nonstore retailers	29,947	372,947	257
598	Fuel dealers	11,317	95,385	155
599	Retail stores, n.e.c.	95,174	468,433	83
601	Central res. depository	102	25,274	191
602	Commercial banks	67,422	1,507,165	40
603	Savings institutions	16,131	262,936	34
606	Credit unions	14,921	163,027	65
608	Foreign banking	656	33,830	47
609	Banking-related functions	5,820	68,711	85
611	Federal credit agencies	1,333	22,884	15
614	Personal cred. institutions	18,996	183,249	11
615	Business cred. institutions	5,358	104,991	42
616	Mortgage bankers & brokers	21,897	226,475	34
621	Security brokers & dealers	25,523	411,411	19
622	Commodity contracts brokers	1,623	13,185	18
623	Security & commod. exchanges	117	7,650	62
628	Security & commod. services	18,123	135,349	12

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSDs, by 3-Digit SIC

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate* (per 10,000 workers)
631	Life insurance	11,754	547,789	32
632	Medical & health insur.	3,337	306,420	114
633	Fire, marine, & caslty ins.	20,361	594,733	83
635	Surety insurance	579	10,255	48
636	Title insurance	2,546	39,886	97
637	Pension and health funds	2,747	33,107	42
639	Ins. carriers, n.e.c.	292	4,018	72
641	Insurance agents	127,278	695,139	28
651	Real estate operators	100,612	499,293	174
653	RE agents and managers	124,530	756,905	73
654	Title abstract offices	5,195	35,417	102
655	Subdividers & developrs	18,561	115,746	201
671	Holding offices	9,575	161,371	57
672	Investment offices	920	24,933	32
673	Trusts	8,841	57,282	56
679	Miscellaneous investing	8,419	56,460	43
701	Hotels and motels	45,252	1,539,037	241
702	Rooming & boarding houses	1,624	9,302	285
703	Camps and rec. vehicle parks	7,435	35,478	21
704	Membership-basis org. hotels	2,410	12,891	21
721	Laundry & garment srvices	56,704	443,179	200
722	Photo studios, portrait	13,168	70,481	74
723	Beauty shops	81,872	390,177	31
724	Barber shops	4,499	14,506	134
725	Shoe repair	2,216	5,807	134
726	Fun. service and crematories	15,784	99,027	65
729	Misc personal services.	30,697	254,674	9
731	Advertising	19,664	242,468	124
732	Credit report.& collection	6,914	109,523	52
733	Mailing, reprod, steno., serv	35,058	285,511	118
734	Services to buildings	65,559	916,370	165
735	Misc. equipt. rental	24,814	229,196	142
736	Pers. supply services	37,374	2,778,419	48
737	Comptr & data proc. services	88,911	1,266,890	33
738	Misc. business services	85,634	1,366,526	70
751	Auto rentals, no drivers	10,643	149,154	93
752	Automobile parking	8,892	65,390	57
753	Automotive repair shops	139,184	608,702	108
754	Automotive serv., exc repair	26,948	211,838	153
762	Electrical repair shops	19,328	144,758	133
763	Watch and jewelry repair	1,805	5,705	133
764	Reupholstery & furn. repair	6,842	22,674	96
769	Misc. repair shops	39,008	262,495	160
781	Motion picture production	14,680	240,953	249
782	Motion picture dist.	1,456	21,899	575
783	Motion picture theaters	6,572	118,921	324
784	Video tape rental	20,816	129,258	312
791	Dance studios & schools	5,719	27,063	203
792	Prducrs, orch., entertainers	16,839	161,158	94
793	Bowling centers	5,735	90,614	50
794	Commercial sports	4,763	101,728	218

Table VIII-1: Estimated Number of Establishments and Employees and Estimated Annual Incidence of All MSDs, by 3-Digit SIC

SIC	Industry	Total Number of Establishments	Total Number of Employees in all Establishments	Total MSD Incidence Rate* (per 10,000 workers)
799	Misc. recreation services	61,841	991,444	181
801	Offices of medical doctors	186,994	1,688,823	78
802	Dentists offices and clinics	113,054	634,709	50
803	Osteopathic physicians	9,105	53,700	28
804	Other health practitioners	84,667	353,204	166
805	Nursing & personal care fac.	24,009	1,806,086	706
806	Hospitals	7,282	5,067,349	327
807	Med. & dental labs	15,243	190,629	84
808	Home hlth care services	16,106	779,365	285
809	Hlth & allied serv., n.e.c.	20,849	387,020	121
811	Legal services	168,276	959,809	39
821	Elem. & secondary schools	18,017	609,190	45
822	Colleges & universities	3,663	1,258,979	46
823	Libraries	2,252	22,343	22
824	Vocational schools	6,816	79,561	23
829	Schools, n.e.c.	15,395	124,076	22
832	Individual & fam. services	43,047	596,191	190
833	Job train. & related serv.	9,114	325,655	107
835	Child day care services	53,592	553,897	80
836	Residential care	28,762	550,745	353
839	Social services, n.e.c.	15,702	216,649	87
841	Museums & art galleries	4,520	63,818	129
842	Bot. & zoolog. gardens	585	16,044	172
861	Business associations	15,767	111,371	30
862	Prof. organizations	7,033	63,638	24
863	Labor organizations	19,536	169,366	16
864	Civic & social assoc.	36,944	369,808	70
865	Political organizations	2,579	10,719	95
866	Religious organizations	158,299	1,380,975	8
869	Membership orgs., n.e.c.	9,072	106,606	81
871	Eng. and arch. services	78,815	910,439	38
872	Accntng, auditng, & bkeeping	84,175	639,896	59
873	Research & testing services	19,471	458,980	113
874	Management & pub. relations	95,033	985,335	69
899	Services, n.e.c.	17,221	105,803	249
	Subtotal	**5,932,581**	**93,577,856**	**220**
	State and local governments	180,201	9,184,961	203
	Total	**6,112,782**	**102,762,817**	**218**

Sources: Office of Regulatory Analysis, OSHA. The numbers of establishments are taken from County Business Patterns, U.S. Bureau of the Census (1996)(Ex. 28-2). The number of MSDs are based on special data runs done by the BLS, based on lost workday cases (with days away from work) from the Annual Survey, 1996 (Ex. 26-1413). MSD rates are calculated by multiplying, for each industry, the number of lost workday (with days away from work) MSDs reported by employers to the BLS by the ratio of all lost workday (with days away from work) injuries and illnesses for that industry to all workday injuries and illnesses for that industry. OSHA used this approach because the BLS only reports the number of lost workday (with days away from work) MSDs by industry.

*Adding the number of currently unreported MSDs that OSHA believes will reported once the standard is in effect and the increase in MSD incidents OSHA believes will occur because persistent signs and symptoms will be reported increases these totals by 50%. (See the benefits chapter for further explanation).

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C. Technological Feasibility (Chapter III)

Chapter 3 of the economic analysis for the final ergonomics rule illustrates the technological feasibility of controlling MSD hazards in problem jobs in accordance with the rule. The analysis presented in this chapter demonstrates that controlling MSD hazards is feasible in the industry sectors included in the scope of the rule.

OSHA has approached the analysis of technological feasibility for the final rule from four perspectives. The four analyses for technological feasibility are:

• Risk factor analysis—This analysis demonstrates the variety of methods available for controlling the five risk factors covered by the rule. Information drawn from the rulemaking record demonstrates how risk factors can be controlled and how these controls can achieve compliance with one or more of the final rule's compliance endpoints.

• Ergonomic program analysis—This analysis demonstrates the feasibility of implementing effective ergonomics programs by identifying cases in the rulemaking record where effective programs, that have program elements similar to or the same as those required by the final rule, have already been implemented.

• Model job analysis—This analysis demonstrates how the risk factors inherent in model jobs that represent the highest rates of lost workday MSDs according to BLS data can be controlled in accordance with the final rule's compliance endpoints. This analysis also presents a model job analysis for video display terminal (VDT) workstations.

• Industry-by-industry analysis—This analysis demonstrates the broad applicability of the available control methods to virtually all of the covered industries, as described by 3-digit SIC codes.

Each of these analyses was performed based on information contained in the rulemaking record. These analyses demonstrate that compliance with the final rule including paragraphs (k)(1)(i) and (k)(1)(ii) is technologically feasible for most processes in most workplaces most of the time.

Finally, controlling MSD hazards in accordance with the final rule can be accomplished (that is, is feasible) because paragraph (k)(1)(iii) of the rule states that employer is only required to reduce hazards to the extent feasible. OSHA expects that employers will implement feasible controls in the context of their own individual workplace. This provision recognizes that, while controlling MSD hazards to one of the levels specified in paragraph (k)(1)(i) or (k)(1)(ii) is feasible in the majority of workplaces, hazard reduction to those levels may not be feasible under certain workplace conditions at certain times.

D. Benefits Analysis (Chapter IV)

In its analysis of both the benefits and costs of the final standard, OSHA has estimated MSD rates based on BLS data. However, as discussed in Chapter IV of the Final Economic Analysis, there is extensive evidence that MSDs are underreported to the BLS. OSHA estimates that there is at least one unreported MSD for every MSD reported to BLS on OSHA logs. However, the final standard creates incentives for employees to report MSDs by providing work restriction protection to employees. The final standard can also be triggered by reports of persistent symptoms. To account for these differences, OSHA estimates that MSD incidents will be reported at a rate 50 percent higher than current MSD rates based on BLS data.

Most of the benefits of the final standard will be generated when employers fix their problem jobs and thus reduce the number of covered MSDs these jobs cause. Hazard information, MSD management and work restriction protection will also generate benefits because they will ensure that MSDs are identified and treated early in their development, thus preventing progression of the MSD to a serious long-term disability. However, OSHA has not found ways to calculate the benefits of early detection, although the Agency is aware that early reporting and medical management have substantial benefits that are similar to those associated with preventive medicine in general. For example, Oxenburgh *et al.* (1985) compared two groups of VDU operators (Ex. 26–1041). In Group A, which did not report early or receive medical management early, 22% of cases were at the second or third stage by the time they sought medical attention, compared with 8% at these stages in Group B, which had been made aware of the need to report early and the value of prompt medical management. The mean period of absence for Group A workers was 33.9 days; only 25% of this group continued to work (*i.e.,* at alternate duty) throughout the period of recuperation. In Group B, however, the mean period of absence from work was only 3.4 days, and fully 80% of this group remained in alternate duty throughout. The mean number of alternate duty days was 91 days for Group A workers and 31.5 days for those in Group B. The total amount of time the average worker in Group A lost, either to days away or alternate duty, was 124.9 days; in Group B, this figure decreased by 72%, to 34.9 days.

The final standard (and therefore this economic analysis) is structured in such a way that the number of jobs fixed in any given year depends on the number of MSD incidents reported that involve workers in jobs that need to be controlled, and the number of workers OSHA estimates hold jobs that involve the same physical work activities as the job giving rise to the reported MSD. For purposes of estimating the number of jobs that will require control under the final standard, OSHA used answers to a Washington state survey indicative of how many workers would be above the compliance endpoint given in Appendix D–1 (Ex. 500–41–3). This survey showed that 37 percent of all workers will be exposed at levels that meet the screen, and thus that their jobs will require job hazard analysis, medical management and work restriction protection. The survey also showed that 33 percent of workers will be above the levels indicated by the hazard identification tools in Appendix D–1, and thus will require hazard controls.

Combining this data allowed OSHA to estimate the number of jobs that would be controlled and the resulting reduction in the number of MSDs projected as a result of the standard. OSHA estimates that employers will be required to fix almost 7 million jobs in the first year the standard is in place, and a diminishing number every year thereafter. Over ten years, approximately 18 million jobs will be fixed. OSHA estimates that fixing these jobs will reduce the number of MSD incidents caused by these jobs by 50 percent per year (based on the effectiveness rate reported in the Risk Assessment section of this preamble) for the next ten years (the time horizon of this analysis). In the first 10 years, the final standard is therefore projected to avert approximately 2.3 million currently reported MSDs and an additional 2.3 million MSDs not currently reported, for a total of 4.6 million MSDs averted. These estimates reflect changes from the estimates in the Preliminary Economic Analysis, which are mainly the result of the inclusion of the screen and clearly defined compliance endpoints in the standard, but are also the result of including unreported MSDs in the analysis of benefits. These changes to the standard make the rule substantially more cost effective then the proposal would have been, because they reduce the number of jobs to be fixed by 40 percent.

OSHA estimates that the direct cost savings associated with each currently reported MSD, including the savings in lost productivity, lost tax payments, and administrative costs for workers' compensation claims, are $27,700 and $7,000 per MSD not currently reported (1996 dollars). (The difference in the dollar values assigned to these two categories of MSDs is attributable to the fact that OSHA assumes that the currently unreported MSDs are much less severe than those being reported.) These direct cost savings do not attribute a value or assign a monetary cost to the pain and suffering of injured or ill workers, losses to their families, or losses of the worker's ability to contribute at home, and are thus conservative estimates of these savings. Based on this estimate of the direct cost savings associated with each reported MSD avoided, the annualized benefits (using a discount rate of 7%) accruing in the first ten years the standard is in effect are estimated to be $9.1 billion per year.

E. Costs of Compliance (Chapter V)

This chapter presents OSHA's estimates of the costs employers would incur to comply with the ergonomics program rule. The costs reported are annualized costs measured in real 1996 dollars over the first 10 years the rule is in effect. To calculate annualized costs, non-recurring costs have been annualized using a discount rate of 7 percent for an estimated life of 10 years. The cost analysis does not account for any changes in the economy over time, or for possible adjustments in the demand and supply of goods, changes in production methods, investment effects, or macroeconomic effects of the standard. Taking account of all of these effects could increase or decrease the cost or benefit estimates presented here, although the macroeconomic effects of any rule whose costs are less than 0.05 percent of GNP are likely to be minimal. OSHA believes that its approach, *i.e.*, of determining the benefits and costs of the standard for industry as it is today, is the least speculative and least controversial way of presenting the benefits and costs of the final standard.

OSHA relied on responses to a 1993 ergonomics survey (see Chapter V of the Final Economic Analysis) of thousands of general industry employers to estimate the extent to which establishments within the scope of the standard already have implemented ergonomics programs involving the control of jobs. This current industry baseline was taken into account in calculating industry-by-industry and size-of-establishment cost estimates, *i.e.*, any costs employers have already incurred, and any benefits they have already accrued, to voluntarily implement such programs have not been attributed to the final rule.

Costs were calculated separately at the three-digit SIC code level for all industries. These industry-by-industry cost estimates account for differences among industries in terms of wage rates, turnover, baseline rates of compliance, and the MSD rate for the industry. To facilitate analysis of the impacts of the final rule on small businesses, costs were calculated separately for each of three size classes of establishments. The Final Regulatory Flexibility Analysis (Section VIII. H. of this Preamble) provides a detailed summary of OSHA's unit cost estimates for each element of the standard.

OSHA estimates that the annualized costs to society of the final standard will be $3.9 billion per year. (All costs are expressed as 1996 dollars and annualized using a 7 percent discount rate and a 10-year annualization period.) Table VIII–2 shows the costs of the final ergonomics standard, by major provision of the standard. Costs are considered in two parts: costs to society and costs to employers. This distinction is necessary because the costs associated with the standard's work restriction protection provisions represent a cost to employers, but not to society as a whole. Table VIII–2 shows that the total estimated costs to society for the private sector are $3.4 billion per year, while estimated costs for all affected parties, including state and local governments, are $3.9 billion per year. Estimated costs to employers in the private sector as a whole are $4 billion per year, and to all affected sectors are $4.5 billion per year.

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TABLE VIII-2

Total Cost of Compliance, by Provision of the Final Rule and 3-Digit SIC

SIC	Industry	Determination of Coverage by the Standard and Grandfather Status	Initial Employer Actions	Programmatic Elements	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
074	Veterinary services	$55,969	$588,438	$2,605,047	$2,242,914	$5,492,368	$1,133,706	$6,626,074
075	Animal serv., excpt vet.	$24,625	$203,956	$477,975	$516,754	$1,223,311	$183,151	$1,406,462
078	Lndscape & hort. services	$188,840	$1,795,148	$8,386,809	$12,248,790	$22,619,588	$3,399,614	$26,019,201
081	Timber tracts	$3,953	$39,766	$165,169	$262,425	$471,313	$53,076	$524,389
083	Forest products	$626	$8,906	$42,185	$83,419	$135,135	$16,561	$151,696
085	Forestry services	$7,187	$66,225	$263,273	$293,718	$630,402	$85,683	$716,085
091	Commerical fishing	$8,926	$70,655	$182,972	$317,470	$580,023	$51,737	$631,759
092	Fish hatcheries	$437	$5,454	$28,537	$50,883	$85,311	$8,660	$93,972
097	Hunting & trapping	$1,555	$12,568	$38,248	$45,082	$97,454	$11,998	$109,451
131	Crude petrol. & nat. gas	$55,733	$552,918	$2,055,016	$1,284,113	$3,947,780	$299,514	$4,247,294
132	Natural gas liquids	$2,567	$35,852	$120,313	$31,634	$190,365	$15,681	$206,046
138	Oil & gas field services	$39,198	$580,050	$3,088,385	$4,190,723	$7,898,356	$923,046	$8,821,401
201	Meat products	$13,593	$2,588,299	$6,600,906	$4,101,152	$13,303,950	$3,032,298	$16,336,248
202	Dairy products	$8,339	$628,553	$3,039,164	$1,890,319	$5,566,375	$1,614,800	$7,181,176
203	Presrvd fruits & vegetables	$10,054	$785,708	$2,727,120	$1,470,897	$4,993,780	$720,509	$5,714,289
204	Grain mill products	$11,931	$586,118	$2,838,747	$1,420,415	$4,857,211	$1,399,678	$6,256,889
205	Bakery products	$17,221	$1,005,032	$4,828,285	$3,214,927	$9,065,466	$2,161,726	$11,227,192
206	Sugar and confect. prods	$6,671	$399,503	$1,961,285	$1,237,414	$3,604,873	$750,688	$4,355,561
207	Fats and oils	$2,649	$107,061	$635,679	$293,416	$1,038,806	$256,745	$1,295,550
208	Beverages	$10,478	$938,667	$3,815,157	$2,155,793	$6,920,096	$2,232,947	$9,153,043
209	Misc. food products	$20,618	$809,121	$3,723,359	$2,375,465	$6,928,564	$1,883,266	$8,811,830
211	Cigarettes	$69	$97,937	$531,148	$147,240	$776,393	$135,586	$911,979
212	Cigars	$215	$9,118	$60,925	$29,143	$99,402	$10,610	$110,012
213	Chewing & smoking tobacco	$119	$16,313	$74,240	$12,207	$102,880	$38,593	$141,473
214	Tobacco stemm. & redrying	$147	$22,104	$127,651	$69,323	$219,225	$41,418	$260,642
221	Brdwven fab. mills, cotton	$1,851	$128,589	$741,588	$706,102	$1,578,130	$151,747	$1,729,877
222	Broadwoven fabric mills	$2,130	$208,724	$1,250,564	$1,054,106	$2,515,525	$256,984	$2,772,508
223	Brdwvn fab. mills, wool	$431	$31,714	$198,060	$154,933	$385,137	$38,112	$423,249
224	Narrow fabric mills	$1,316	$82,035	$380,830	$206,446	$670,627	$122,973	$793,599
225	Knitting mills	$8,083	$524,251	$2,777,945	$2,484,621	$5,794,900	$762,174	$6,557,074
226	Tex. finishing, excpt wool	$3,507	$173,626	$927,163	$725,422	$1,829,719	$249,130	$2,078,849
227	Carpets and rugs	$2,002	$125,134	$760,187	$795,415	$1,682,738	$162,841	$1,845,579
228	Yarn and thread mills	$2,211	$210,688	$1,278,852	$1,096,440	$2,588,191	$351,597	$2,939,788
229	Misc. textile goods	$4,437	$182,041	$1,172,927	$801,729	$2,161,135	$250,326	$2,411,461
231	Men's & boys' suits & coats	$1,073	$89,146	$387,719	$142,439	$620,376	$197,924	$818,300
232	Men's & boys' furnishings	$9,488	$825,825	$3,188,101	$1,106,771	$5,130,185	$1,828,868	$6,959,053
233	Wm's & misses' outerwear	$36,327	$742,250	$3,244,855	$1,117,179	$5,140,611	$1,283,083	$6,423,694
234	Wm's & chldrn's undergarmnts	$1,310	$103,386	$446,978	$243,098	$794,772	$255,395	$1,050,167
235	Hats, caps, & millinery	$1,681	$70,760	$284,804	$77,772	$435,018	$141,430	$576,448
236	Girls' & chldrn's outerwear	$1,424	$71,072	$357,755	$186,262	$616,513	$198,933	$815,446
237	Fur goods	$610	$5,489	$13,943	$378	$20,419	$6,004	$26,422
238	Misc. apparel & accessories	$4,044	$109,750	$463,615	$199,686	$777,095	$221,162	$998,257
239	Misc. fab. textile prods	$37,083	$874,699	$3,489,164	$1,670,026	$6,070,972	$1,455,258	$7,526,231
241	Logging	$65,420	$529,416	$1,321,210	$204,115	$2,120,161	$255,264	$2,375,425
242	Sawmills & planing mills	$24,881	$686,429	$3,874,027	$1,580,688	$6,166,026	$2,228,080	$8,394,106
243	Millwork & plywood	$40,059	$1,297,153	$7,029,948	$3,479,519	$11,846,680	$3,521,207	$15,367,887
244	Wood containers	$6,721	$142,124	$999,479	$431,153	$1,579,477	$608,432	$2,187,909
245	Wood bldings & mobile homes	$4,814	$459,960	$2,234,692	$1,390,848	$4,090,315	$1,297,456	$5,387,771
249	Misc. wood products	$14,556	$365,479	$2,229,773	$1,005,085	$3,614,893	$972,867	$4,587,760
251	Household furniture	$21,334	$1,010,631	$5,741,490	$3,850,344	$10,623,799	$2,940,095	$13,563,894
252	Office furniture	$5,602	$369,083	$1,707,485	$970,195	$3,052,363	$817,340	$3,869,704
253	Pub blding & related furn.	$1,919	$335,117	$1,070,938	$518,092	$1,926,066	$1,035,766	$2,961,832
254	Partitions and fixtures	$10,791	$355,056	$2,179,260	$1,116,668	$3,661,776	$1,109,529	$4,771,304
259	Misc furniture and fixtures	$6,874	$182,081	$993,025	$484,807	$1,666,786	$412,696	$2,079,483
261	Pulp mills	$324	$46,687	$298,324	$229,097	$574,432	$82,907	$657,339
262	Paper mills	$1,981	$649,102	$3,460,912	$2,198,668	$6,310,663	$1,382,580	$7,693,243
263	Paperboard mills	$1,318	$207,462	$1,304,949	$832,613	$2,346,342	$328,005	$2,674,347
265	Paperbrd containers & boxes	$14,732	$896,278	$5,332,799	$2,946,155	$9,189,964	$2,737,192	$11,927,157
267	Misc. cnvrtd paper products	$19,268	$1,075,669	$6,055,066	$3,471,157	$10,621,160	$2,599,663	$13,220,823
271	Newspapers	$48,845	$1,511,961	$8,613,891	$5,733,496	$15,908,193	$2,857,965	$18,766,157
272	Periodicals	$23,797	$437,055	$2,124,578	$781,682	$3,367,112	$628,385	$3,995,497
273	Books	$17,468	$502,646	$2,768,353	$1,500,855	$4,789,322	$1,043,296	$5,832,617
274	Miscellaneous publishing	$18,253	$264,573	$1,188,860	$420,429	$1,892,115	$363,052	$2,255,167

TABLE VIII-2

Total Cost of Compliance, by Provision of the Final Rule and 3-Digit SIC

SIC	Industry	Determination of Coverage by the Standard and Grandfather Status	Initial Employer Actions	Programmatic Elements	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
275	Commercial printing	$162,875	$2,818,804	$14,432,151	$4,633,999	$22,047,829	$5,834,443	$27,882,271
276	Manifold business forms	$4,057	$202,624	$1,218,787	$390,588	$1,816,055	$666,313	$2,482,368
277	Greeting cards	$787	$100,929	$498,029	$412,292	$1,012,036	$260,697	$1,272,733
278	Blankbooks & bookbinding	$7,237	$247,600	$1,417,307	$855,181	$2,527,325	$787,274	$3,314,599
279	Printing trade services	$20,536	$291,497	$1,240,279	$133,605	$1,685,917	$332,569	$2,018,486
281	Indust. inorganic chemicals	$8,693	$306,622	$2,099,035	$750,038	$3,164,388	$344,332	$3,508,720
282	Plastics mat. & synthetics	$5,357	$367,011	$2,693,915	$835,017	$3,901,299	$487,000	$4,388,299
283	Drugs	$10,983	$712,341	$4,881,682	$1,700,749	$7,305,755	$939,846	$8,245,601
284	Soap, clnrs, & toilet goods	$14,836	$457,693	$2,648,592	$1,132,387	$4,253,509	$719,658	$4,973,167
285	Paints & allied products	$6,849	$189,627	$1,125,886	$365,304	$1,687,666	$397,561	$2,085,227
286	Indust. organic chemicals	$7,882	$423,075	$3,297,923	$840,591	$4,569,471	$396,770	$4,966,241
287	Agricultural chemicals	$5,235	$135,812	$893,979	$295,265	$1,330,290	$176,220	$1,506,510
289	Misc. chemical products	$14,016	$364,598	$2,107,295	$632,028	$3,117,937	$636,257	$3,754,194
291	Petroleum refining	$2,324	$247,569	$2,111,894	$1,165,413	$3,527,201	$296,883	$3,824,084
295	Asphlt pavng & roofng mat.	$6,714	$123,234	$760,392	$534,403	$1,424,742	$317,260	$1,742,001
299	Misc. pet. & coal prods	$1,964	$44,975	$289,144	$182,889	$518,972	$76,690	$595,662
301	Tires and inner tubes	$795	$398,043	$1,816,635	$533,999	$2,749,473	$951,404	$3,700,877
302	Rubber & plastics footwear	$280	$25,885	$147,182	$79,900	$253,247	$67,969	$321,216
305	Hose, bltng, and gaskets	$3,711	$287,274	$1,301,329	$556,788	$2,149,101	$776,244	$2,925,345
306	Fab. rubber prod., n.e.c.	$8,078	$538,299	$2,419,814	$1,030,324	$3,996,514	$1,480,995	$5,477,509
308	Misc plastics, n.e.c.	$61,313	$2,943,333	$15,241,306	$6,318,264	$24,564,216	$7,959,889	$32,524,105
311	Leather tan. & finishing	$1,572	$73,473	$389,623	$303,266	$767,935	$115,175	$883,110
313	Footwear cut stock	$321	$7,756	$47,843	$32,420	$88,340	$12,652	$100,992
314	Footwear, except rubber	$1,668	$143,027	$754,727	$845,138	$1,744,560	$257,376	$2,001,936
315	Leather gloves & mittens	$316	$14,056	$70,948	$21,608	$106,928	$26,772	$133,700
316	Luggage	$945	$24,258	$167,941	$123,403	$316,548	$39,749	$356,297
317	Hndbags & prsnal leathr gds.	$828	$22,755	$145,147	$179,221	$347,951	$53,898	$401,849
319	Leather goods, n.e.c.	$1,299	$33,883	$193,758	$138,565	$367,504	$73,029	$440,533
321	Flat glass	$385	$96,829	$423,991	$167,108	$688,313	$290,691	$979,004
322	Glass, pressed or blown	$4,488	$481,782	$1,962,157	$700,054	$3,148,482	$1,028,009	$4,176,490
323	Prod. of purchased glass	$8,990	$362,565	$1,556,345	$762,019	$2,689,919	$961,169	$3,651,089
324	Cement, hydraulic	$1,202	$76,968	$456,106	$165,754	$700,031	$203,517	$903,547
325	Structural clay products	$3,133	$166,865	$768,296	$324,595	$1,262,890	$542,964	$1,805,854
326	Pottery & related prods	$5,795	$244,496	$991,631	$466,752	$1,708,674	$747,750	$2,456,424
327	Concrete & plast. prdcts	$43,797	$971,492	$5,077,569	$2,030,043	$8,122,900	$2,883,383	$11,006,283
328	Cut stone & stone prods	$4,909	$85,304	$398,444	$143,405	$632,062	$216,118	$848,181
329	Misc. nonmet. mineral prods.	$7,373	$336,233	$1,717,979	$796,369	$2,857,954	$928,504	$3,786,458
331	Basic steel products	$7,318	$1,240,400	$6,532,050	$2,799,954	$10,579,722	$1,811,465	$12,391,187
332	Iron and steel foundries	$5,005	$840,061	$3,451,950	$1,485,615	$5,782,630	$1,944,419	$7,727,050
333	Primary nonfer. metals	$963	$166,492	$880,140	$386,435	$1,434,030	$284,749	$1,718,779
334	Secondary nonfer. metals	$1,290	$80,063	$404,165	$182,397	$667,915	$170,715	$838,630
335	Nonfer. rolling & drawing	$6,276	$853,464	$3,999,413	$1,713,911	$6,573,065	$1,445,074	$8,018,138
336	Nonfer. foundries (cstngs)	$7,565	$500,196	$2,184,084	$937,174	$3,629,019	$1,084,850	$4,713,869
339	Misc. primary metal prdcts	$4,198	$120,627	$733,440	$285,218	$1,143,483	$187,995	$1,331,479
341	Met. cans & ship. containers	$2,178	$160,446	$954,624	$381,749	$1,498,998	$386,555	$1,885,553
342	Cutlery, hndtls, & hardware	$12,150	$621,430	$3,115,548	$1,682,397	$5,431,524	$1,393,666	$6,825,191
343	Plumbing & heating fixtures	$3,091	$312,675	$1,193,346	$633,839	$2,142,951	$854,040	$2,996,991
344	Fab. struct. metal prdcts	$56,999	$1,837,200	$10,212,496	$5,052,945	$17,159,640	$4,845,115	$22,004,754
345	Screw machine products	$11,483	$454,082	$2,534,878	$919,574	$3,920,018	$1,226,009	$5,146,027
346	Met. forgings & stampings	$17,399	$1,557,380	$7,024,442	$3,414,725	$12,013,946	$3,655,488	$15,669,434
347	Metal services, n.e.c.	$23,744	$515,811	$2,937,435	$982,639	$4,459,629	$1,367,553	$5,827,182
348	Ordnance and access., n.e.c.	$2,540	$164,854	$913,961	$453,697	$1,535,051	$279,189	$1,814,240
349	Misc. fab. metal products	$31,923	$1,255,921	$6,822,257	$3,288,392	$11,398,493	$3,226,235	$14,624,727
351	Engines and turbines	$2,085	$427,395	$2,021,296	$841,208	$3,291,985	$822,415	$4,114,400
352	Farm & garden machinery	$10,664	$559,351	$2,578,271	$1,395,958	$4,544,244	$1,002,812	$5,547,056
353	Construct. & related mach.	$15,722	$923,123	$4,625,925	$2,587,324	$8,152,095	$2,104,568	$10,256,663
354	Metalworking machinery	$54,696	$1,358,566	$7,667,849	$3,004,592	$12,085,703	$2,824,220	$14,909,924
355	Special industry mach.	$23,604	$791,696	$4,540,533	$2,003,262	$7,359,095	$1,603,010	$8,962,105
356	General indust. mach.	$21,227	$1,100,776	$6,093,125	$2,911,717	$10,126,846	$2,508,981	$12,635,827
357	Computer & office equip.	$13,751	$749,585	$4,876,439	$2,239,656	$7,879,432	$1,009,045	$8,888,477
358	Refrig. & serv. indust mach.	$11,601	$1,033,526	$4,685,495	$2,738,590	$8,469,212	$2,261,972	$10,731,185
359	Industrial mach., n.e.c.	$122,899	$1,859,043	$9,613,509	$2,686,355	$14,281,806	$3,299,837	$17,581,643
361	Elect. dist. equipment	$4,693	$256,976	$1,344,960	$477,969	$2,084,598	$406,340	$2,490,937

TABLE VIII-2

Total Cost of Compliance, by Provision of the Final Rule and 3-Digit SIC

SIC	Industry	Determination of Coverage by the Standard and Grandfather Status	Initial Employer Actions	Programmatic Elements	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
362	Elect. indust. apparatus	$13,552	$754,618	$3,418,998	$1,090,690	$5,277,858	$1,084,770	$6,362,629
363	Household appliances	$2,645	$621,484	$2,350,652	$915,422	$3,890,204	$957,481	$4,847,685
364	Elct. lghtng & wire equip.	$10,767	$670,421	$3,168,847	$1,111,947	$4,961,983	$1,099,752	$6,061,735
365	Household audio & vid. equip.	$4,452	$207,201	$953,892	$344,385	$1,509,930	$307,849	$1,817,780
366	Communications equipment	$13,530	$647,168	$4,627,855	$1,578,921	$6,867,474	$680,777	$7,548,252
367	Electrnic compnnts & access.	$35,756	$1,492,089	$10,097,206	$3,434,881	$15,059,932	$1,889,014	$16,948,945
369	Misc. elect. equipment	$8,917	$683,419	$3,235,519	$1,100,278	$5,028,133	$1,101,842	$6,129,975
371	Motor vehicles & equipt.	$31,675	$8,467,592	$28,373,297	$3,172,775	$40,045,340	$7,514,490	$47,559,830
372	Aircraft and parts	$12,833	$1,664,662	$12,039,124	$1,321,782	$15,038,401	$1,133,605	$16,172,006
373	Ship, boat blding and repair	$14,670	$950,348	$2,205,130	$218,915	$3,389,062	$936,226	$4,325,288
374	Railroad equipment	$965	$154,492	$913,690	$153,685	$1,222,831	$178,975	$1,401,806
375	Motorcycles & bicycles	$2,131	$96,177	$483,804	$63,834	$645,947	$82,347	$728,294
376	Guided missiles	$634	$124,006	$1,969,104	$190,859	$2,284,603	$91,839	$2,376,442
379	Misc. transportation equip.	$5,481	$239,854	$1,181,693	$235,047	$1,662,075	$265,396	$1,927,471
381	Srch & navigation equipment	$4,408	$452,314	$3,290,313	$1,199,299	$4,946,334	$384,489	$5,330,824
382	Meas. & contrlling devices	$27,290	$940,171	$4,835,510	$2,075,917	$7,878,889	$1,233,858	$9,112,747
384	Medical instrmnts & supplies	$26,280	$854,710	$4,510,790	$2,399,357	$7,791,136	$1,101,303	$8,892,440
385	Ophthalmic goods	$3,055	$93,564	$426,381	$216,660	$739,660	$143,080	$882,740
386	Photo. equip. & supplies	$3,425	$246,659	$1,262,406	$565,678	$2,078,167	$354,552	$2,432,719
387	Watches, clocks, & parts	$646	$13,803	$73,993	$52,079	$140,522	$20,118	$160,640
391	Jwlry, slvrwre, and plate	$12,693	$177,563	$742,080	$393,136	$1,325,472	$219,739	$1,545,211
393	Musical instruments	$2,351	$66,870	$263,887	$142,370	$475,478	$128,325	$603,803
394	Toys and sporting goods	$17,530	$553,613	$2,072,474	$1,070,936	$3,714,552	$937,139	$4,651,691
395	Office and art supplies	$5,957	$108,795	$499,598	$247,340	$861,691	$136,709	$998,400
396	Costume jewelry & notions	$4,560	$66,823	$318,357	$179,385	$569,124	$102,987	$672,112
399	Misc. manufactures	$35,192	$658,528	$3,156,931	$1,561,055	$5,411,707	$1,275,903	$6,687,609
411	Local & suburban trans.	$31,705	$879,339	$5,498,267	$9,357,380	$15,766,692	$2,758,501	$18,525,193
412	Taxicabs	$9,024	$104,907	$386,764	$1,040,205	$1,540,900	$91,676	$1,632,576
413	Intercty & rural bus trans.	$2,205	$88,396	$549,307	$1,173,800	$1,813,708	$187,589	$2,001,297
414	Bus charter service	$4,506	$84,789	$452,518	$789,102	$1,330,914	$154,912	$1,485,827
415	School buses	$10,004	$323,422	$1,819,403	$5,115,900	$7,268,729	$587,532	$7,856,261
417	Bus terminals	$261	$3,357	$19,729	$10,012	$33,359	$7,297	$40,656
421	Trking & Courier Service	$474,111	$8,569,105	$48,168,979	$92,020,966	$149,233,161	$14,075,047	$163,308,208
422	Pub. warehousing & storage	$54,342	$836,068	$5,016,103	$4,699,375	$10,605,888	$2,053,386	$12,659,274
423	Trucking terminal fac.	$367	$5,982	$35,924	$36,294	$78,566	$15,037	$93,603
431	Postal Service	$154,767	$4,837,885	$25,246,411	$20,826,211	$51,065,275	$8,149,885	$59,215,160
451	Air trans., scheduled	$35,179	$7,051,190	$23,793,281	$24,716,741	$55,596,390	$22,843,978	$78,440,368
452	Air trans., nonsched.	$6,595	$140,463	$608,002	$607,370	$1,362,430	$246,330	$1,608,760
458	Airports and services	$14,855	$536,617	$2,733,673	$3,538,770	$6,823,916	$1,363,095	$8,187,010
461	Pipelines, excpt natural gas	$5,679	$119,733	$756,192	$408,326	$1,289,930	$283,775	$1,573,705
472	Pass. trans. arrangements	$106,795	$1,084,760	$1,765,395	$1,387,235	$4,344,185	$368,516	$4,712,700
473	Freight trans. arrangements	$60,804	$744,112	$3,663,401	$3,566,503	$8,034,819	$1,036,172	$9,070,991
474	Rental of railroad cars	$532	$8,785	$47,357	$34,380	$91,054	$8,063	$99,116
478	Misc. trans. services	$11,991	$218,055	$1,410,478	$1,410,264	$3,050,789	$492,979	$3,543,768
481	Telephone communication	$165,186	$2,540,678	$9,641,669	$8,223,518	$20,571,051	$4,726,001	$25,297,052
482	Telegrph & other comm.	$2,136	$20,286	$46,871	$29,169	$98,462	$27,206	$125,668
483	Radio & TV broadcasting	$42,304	$506,201	$1,452,059	$432,651	$2,433,216	$559,575	$2,992,791
484	Cable & othr pay TV services	$21,122	$410,533	$1,644,018	$1,482,638	$3,558,311	$1,421,791	$4,980,102
489	Communication serv., n.e.c.	$4,564	$50,317	$122,310	$68,144	$245,335	$65,679	$311,015
491	Electric services	$38,267	$1,195,172	$4,952,071	$3,462,565	$9,648,075	$2,986,488	$12,634,563
492	Gas product. & distribution	$24,958	$523,602	$1,936,255	$1,294,042	$3,778,856	$1,326,840	$5,105,696
493	Comb. utility services	$9,442	$456,548	$2,209,017	$1,856,878	$4,531,885	$1,039,235	$5,571,120
494	Water supply	$16,700	$161,319	$401,591	$168,571	$748,180	$315,372	$1,063,552
495	Sanitary services	$34,556	$784,892	$2,200,598	$1,607,906	$4,627,952	$2,623,475	$7,251,426
496	Steam & air-cond. supplies	$316	$4,302	$15,117	$5,679	$25,415	$10,406	$35,821
497	Irrigation systems	$1,678	$13,132	$19,939	$7,010	$41,758	$12,912	$54,670
501	Motor vehicles	$199,317	$2,736,078	$14,149,232	$9,682,724	$26,767,352	$5,987,351	$32,754,703
502	Furn. & homefurnishings	$81,600	$1,050,723	$5,189,736	$2,967,076	$9,289,135	$2,212,121	$11,501,256
503	Lumber & construct. mat.	$100,280	$1,678,744	$9,645,199	$5,895,138	$17,319,362	$5,326,062	$22,645,424
504	Prof. & commercial equip.	$253,900	$3,881,705	$19,189,460	$11,549,192	$34,874,258	$5,350,277	$40,224,535
505	Met. & minerals, excpt pet.	$52,415	$887,029	$4,984,758	$3,197,406	$9,121,609	$2,277,944	$11,399,553
506	Electrical goods	$151,874	$2,361,944	$12,006,584	$7,227,119	$21,747,520	$4,371,686	$26,119,207
507	Hardware supplies	$118,372	$1,694,420	$9,189,629	$4,802,046	$15,804,467	$4,223,748	$20,028,215

TABLE VIII-2

Total Cost of Compliance, by Provision of the Final Rule and 3-Digit SIC

SIC	Industry	Determination of Coverage by the Standard and Grandfather Status	Initial Employer Actions	Programmatic Elements	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
508	Mach., equipt, & supplies	$368,197	$4,779,641	$23,884,205	$12,382,614	$41,414,657	$9,352,640	$50,767,296
509	Misc. durable goods	$183,472	$2,042,870	$8,892,024	$5,951,886	$17,070,251	$3,626,502	$20,696,753
511	Paper and paper products	$80,730	$1,220,386	$6,366,147	$5,819,268	$13,486,531	$1,796,301	$15,282,832
512	Drugs, propriet., & sundries	$47,345	$893,149	$4,996,415	$3,468,063	$9,404,972	$1,177,883	$10,582,855
513	Apparel and notions	$118,459	$1,282,074	$5,227,549	$2,828,796	$9,456,877	$1,677,778	$11,134,655
514	Groceries & related products	$204,015	$4,794,617	$26,365,537	$21,322,708	$52,686,876	$13,653,303	$66,340,179
515	Farm-prod. raw materials	$37,622	$393,071	$1,346,666	$729,898	$2,507,258	$534,182	$3,041,440
516	Chemicals & allied prods	$80,164	$978,067	$4,446,009	$2,602,540	$8,106,780	$1,387,745	$9,494,525
517	Petrol. & petrol. prods	$58,936	$752,204	$3,657,551	$2,607,967	$7,076,658	$1,410,542	$8,487,200
518	Beer, wine, & dist. bev.	$24,810	$982,828	$5,367,795	$3,985,910	$10,361,342	$3,301,879	$13,663,221
519	Misc. nondurable goods	$255,925	$2,915,918	$11,508,351	$9,825,998	$24,506,193	$4,364,463	$28,870,656
521	Lumber & other blding mat.	$96,047	$2,318,542	$13,414,817	$11,382,823	$27,212,229	$7,755,463	$34,967,693
523	Paint, glass, wallpaper strs	$23,993	$275,025	$1,398,035	$836,156	$2,533,209	$764,321	$3,297,530
525	Hardware stores	$42,397	$516,825	$2,543,280	$1,579,168	$4,681,670	$1,308,045	$5,989,715
526	Retail nurseries and gardens	$37,431	$421,793	$2,004,890	$1,796,097	$4,260,211	$987,917	$5,248,128
527	Mobile home dealers	$23,271	$291,429	$1,582,135	$930,618	$2,827,454	$663,488	$3,490,941
531	Department stores	$26,134	$4,758,318	$27,485,467	$30,203,589	$62,473,509	$26,625,089	$89,098,598
533	Variety stores	$32,847	$492,101	$3,004,259	$979,567	$4,508,774	$1,967,347	$6,476,122
539	Misc. gen. merchandise strs.	$57,689	$951,668	$4,942,827	$4,034,638	$9,986,823	$2,165,910	$12,152,733
541	Grocery stores	$513,744	$10,906,931	$57,931,536	$43,984,501	$113,336,712	$21,441,547	$134,778,259
542	Meat and fish markets	$36,063	$325,618	$1,048,864	$659,674	$2,070,219	$279,086	$2,349,305
543	Fruit & vegetable markets	$15,318	$128,681	$311,558	$137,018	$592,576	$80,225	$672,801
544	Candy, nut, & confctnry strs	$21,735	$181,309	$425,977	$140,738	$769,760	$104,329	$874,089
545	Dairy products stores	$11,688	$95,140	$191,282	$67,119	$365,230	$42,855	$408,085
546	Retail bakeries	$92,386	$829,425	$2,499,612	$927,185	$4,348,608	$698,732	$5,047,340
549	Misc. food stores	$45,396	$373,044	$828,107	$278,429	$1,524,975	$202,248	$1,727,223
551	New and used car dealers	$102,887	$3,973,879	$23,828,713	$24,194,669	$52,100,148	$8,877,486	$60,977,634
552	Used car dealers	$100,614	$767,479	$578,664	$287,086	$1,733,843	$157,960	$1,891,804
553	Auto & home supply stores	$148,247	$1,716,003	$8,082,708	$7,365,986	$17,312,944	$3,686,269	$20,999,213
554	Gas service stations	$312,347	$3,017,423	$9,817,686	$6,806,970	$19,954,426	$4,440,062	$24,394,488
555	Boat dealers	$23,229	$240,654	$1,013,088	$647,812	$1,924,783	$367,148	$2,291,931
556	Rec. vehicle dealers	$13,728	$183,300	$968,055	$666,521	$1,831,603	$385,491	$2,217,094
557	Motorcycle dealers	$17,349	$158,582	$153,829	$97,087	$426,846	$37,524	$464,370
559	Auto dealers, n.e.c.	$5,656	$45,444	$39,719	$25,522	$116,341	$10,337	$126,679
561	Men's & boys' clothing strs	$38,083	$387,387	$881,897	$458,056	$1,765,423	$371,112	$2,136,535
562	Women's clothing stores	$179,801	$1,547,208	$2,567,004	$1,081,052	$5,375,065	$817,737	$6,192,802
563	Wm's access.& specialty strs	$39,634	$311,721	$405,770	$140,895	$898,020	$129,618	$1,027,638
564	Chldrn's & infants' wear strs	$23,770	$212,347	$457,426	$314,995	$1,008,539	$145,279	$1,153,818
565	Family clothing stores	$82,550	$1,190,304	$6,372,761	$4,098,718	$11,744,333	$2,459,472	$14,203,805
566	Shoe stores	$171,469	$1,331,150	$2,427,966	$867,596	$4,798,180	$739,159	$5,537,339
569	Misc. apparel stores	$43,235	$334,044	$332,132	$119,978	$829,388	$105,855	$935,244
571	Furnitre & homefurnishng strs	$259,944	$2,969,361	$13,896,392	$9,666,207	$26,791,904	$5,863,770	$32,655,674
572	Household appliance strs	$56,657	$556,743	$2,245,505	$1,553,847	$4,412,751	$673,118	$5,085,868
573	Radio, TV, & comptr strs	$172,444	$1,838,319	$5,947,343	$4,045,186	$12,003,294	$1,914,867	$13,918,160
581	Eating & drinking places	$2,095,210	$22,504,303	$86,715,409	$35,641,406	$146,956,328	$22,837,677	$169,794,005
591	Drug stores	$190,746	$2,267,973	$7,985,455	$5,683,952	$16,128,126	$2,520,539	$18,648,665
592	Liquor stores	$78,688	$666,783	$655,707	$187,680	$1,588,858	$262,411	$1,851,269
593	Used merchandise stores	$105,215	$853,025	$2,192,949	$1,279,547	$4,430,735	$825,297	$5,256,032
594	Misc. shopping goods strs.	$544,356	$4,846,691	$13,806,775	$8,051,847	$27,249,668	$5,065,009	$32,314,677
596	Nonstore retailers	$149,352	$2,067,192	$10,324,897	$9,270,898	$21,812,338	$3,595,431	$25,407,770
598	Fuel dealers	$36,059	$461,740	$1,930,478	$2,052,933	$4,481,211	$777,947	$5,259,158
599	Retail stores, n.e.c.	$384,242	$3,176,539	$4,775,100	$4,041,095	$12,376,976	$1,456,614	$13,833,591
601	Central res. depository	$517	$73,561	$319,896	$80,473	$474,447	$57,127	$531,574
602	Commercial banks	$342,919	$4,660,906	$15,908,940	$3,759,259	$24,672,024	$1,107,229	$25,779,253
603	Savings institutions	$84,279	$970,187	$2,691,145	$397,188	$4,142,800	$188,748	$4,331,547
606	Credit unions	$59,059	$657,419	$1,781,402	$292,134	$2,790,014	$212,667	$3,002,681
608	Foreign banking	$5,154	$83,205	$263,402	$3,306	$355,067	$919	$355,986
609	Banking-related functions	$30,177	$325,592	$886,816	$197,889	$1,440,474	$88,070	$1,528,544
611	Federal credit agencies	$6,727	$88,272	$246,743	$27,659	$369,402	$7,111	$376,512
614	Personal cred. institutions	$101,880	$932,402	$1,704,470	$160,249	$2,899,000	$43,012	$2,942,012
615	Business cred. institutions	$32,447	$438,821	$1,446,035	$267,294	$2,184,597	$76,526	$2,261,122
616	Mortgage bankers & brokers	$116,138	$1,202,703	$2,809,569	$348,486	$4,476,897	$158,378	$4,635,274
621	Security brokers & dealers	$116,984	$1,903,107	$5,767,549	$773,864	$8,561,504	$158,272	$8,719,776

TABLE VIII-2

Total Cost of Compliance, by Provision of the Final Rule and 3-Digit SIC

SIC	Industry	Determination of Coverage by the Standard and Grandfather Status	Initial Employer Actions	Programmatic Elements	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
622	Commodity contracts brokers	$6,039	$73,199	$144,925	$0	$224,162	$0	$224,162
623	Security & commod. exchanges	$536	$27,654	$126,764	$25,663	$180,618	$7,244	$187,861
628	Security & commod. services	$111,903	$1,064,686	$1,920,203	$178,167	$3,274,960	$37,005	$3,311,965
631	Life insurance	$76,996	$1,845,142	$8,161,573	$1,983,456	$12,067,167	$288,300	$12,355,467
632	Medical & health insur.	$18,029	$1,036,549	$4,808,503	$1,616,296	$7,479,377	$442,124	$7,921,501
633	Fire, marine, & caslty ins.	$124,916	$2,683,416	$10,636,225	$1,856,866	$15,301,422	$680,040	$15,981,462
635	Surety insurance	$3,552	$49,363	$159,132	$27,381	$239,428	$8,508	$247,936
636	Title insurance	$10,984	$181,641	$644,715	$117,528	$954,868	$64,360	$1,019,228
637	Pension and health funds	$15,059	$178,251	$477,404	$61,045	$731,759	$25,787	$757,546
639	Ins. carriers, n.e.c.	$1,338	$19,258	$61,550	$9,811	$91,957	$5,364	$97,321
641	Insurance agents	$647,355	$5,667,437	$9,170,808	$763,023	$16,248,624	$436,502	$16,685,126
651	Real estate operators	$376,329	$3,889,293	$9,806,761	$3,135,865	$17,208,248	$1,484,820	$18,693,068
653	RE agents and managers	$547,121	$5,406,985	$11,967,801	$3,446,138	$21,368,045	$1,051,004	$22,419,049
654	Title abstract offices	$20,768	$214,891	$437,999	$25,513	$699,171	$26,201	$725,371
655	Subdividers & developrs	$69,426	$810,581	$2,291,421	$999,106	$4,170,534	$369,463	$4,539,996
671	Holding offices	$57,038	$797,037	$2,602,016	$730,448	$4,186,539	$155,625	$4,342,164
672	Investment offices	$4,217	$89,445	$351,813	$151,246	$596,721	$11,791	$608,512
673	Trusts	$42,342	$410,614	$867,929	$174,395	$1,495,281	$63,585	$1,558,865
679	Miscellaneous investing	$40,988	$395,538	$948,082	$209,780	$1,594,389	$80,080	$1,674,469
701	Hotels and motels	$165,678	$4,578,542	$27,058,668	$19,917,858	$51,720,746	$9,954,201	$61,674,948
702	Rooming & boarding houses	$7,444	$56,604	$55,320	$12,354	$131,722	$8,021	$139,743
703	Camps and rec. vehicle parks	$15,009	$133,584	$154,919	$86,649	$390,160	$30,446	$420,606
704	Membership-basis org. hotels	$11,046	$82,827	$78,882	$19,084	$191,839	$11,022	$202,861
721	Laundry & garment srvices	$195,263	$2,035,420	$9,127,876	$4,801,815	$16,160,374	$4,440,040	$20,600,413
722	Photo studios, portrait	$36,224	$320,556	$833,701	$677,906	$1,868,387	$181,148	$2,049,535
723	Beauty shops	$191,194	$1,682,771	$2,357,653	$829,755	$5,061,373	$566,039	$5,627,412
724	Barber shops	$20,621	$152,738	$306,468	$90,745	$570,572	$84,274	$654,847
725	Shoe repair	$10,157	$72,556	$122,831	$60,316	$265,860	$34,408	$300,268
726	Fun. service and crematories	$64,349	$538,340	$1,175,493	$603,434	$2,381,616	$284,746	$2,666,361
729	Misc personal services.	$127,577	$1,082,588	$1,167,796	$598,649	$2,976,610	$114,649	$3,091,259
731	Advertising	$90,129	$1,229,047	$4,407,958	$1,607,005	$7,334,140	$346,006	$7,680,146
732	Credit report.& collection	$39,407	$468,453	$1,686,618	$358,665	$2,553,144	$173,623	$2,726,767
733	Mailing, reprod, steno., serv	$145,007	$1,550,343	$5,198,639	$2,484,705	$9,378,694	$900,986	$10,279,680
734	Services to buildings	$206,294	$2,945,347	$12,847,705	$2,472,147	$18,471,493	$3,347,075	$21,818,569
735	Misc. equipt. rental	$91,341	$1,116,432	$4,366,235	$3,079,884	$8,653,891	$892,842	$9,546,733
736	Pers. supply services	$137,575	$6,306,756	$37,298,132	$35,295,716	$79,038,179	$3,431,713	$82,469,891
737	Comptr & data proc. services	$469,811	$6,794,327	$23,909,335	$6,545,429	$37,718,903	$1,267,004	$38,985,907
738	Misc. business services	$277,937	$4,088,846	$17,217,271	$9,519,201	$31,103,255	$2,536,666	$33,639,921
751	Auto rentals, no drivers	$58,976	$662,777	$2,655,497	$2,659,082	$6,036,333	$509,081	$6,545,414
752	Automobile parking	$29,212	$260,778	$600,376	$718,520	$1,608,886	$164,198	$1,773,084
753	Automotive repair shops	$600,485	$4,982,777	$11,845,914	$7,933,858	$25,363,033	$2,814,592	$28,177,625
754	Automotive serv., exc repair	$86,397	$942,031	$4,223,375	$3,359,926	$8,611,728	$1,591,359	$10,203,088
762	Electrical repair shops	$78,797	$830,539	$2,955,619	$2,677,290	$6,542,245	$745,888	$7,288,133
763	Watch and jewelry repair	$8,273	$64,212	$134,971	$66,847	$274,303	$32,534	$306,837
764	Reupholstery & furn. repair	$31,361	$238,519	$418,835	$217,220	$905,934	$131,110	$1,037,044
769	Misc. repair shops	$152,081	$1,590,294	$5,966,360	$5,208,233	$12,916,969	$1,531,232	$14,448,201
781	Motion picture production	$73,503	$1,534,398	$8,091,912	$3,789,060	$13,488,873	$1,500,575	$14,989,448
782	Motion picture dist.	$6,166	$125,308	$663,561	$279,892	$1,074,927	$208,586	$1,283,513
783	Motion picture theaters	$15,217	$456,773	$2,961,215	$914,394	$4,347,599	$1,235,374	$5,582,973
784	Video tape rental	$81,980	$807,713	$3,651,598	$323,192	$4,864,483	$1,354,524	$6,219,007
791	Dance studios & schools	$26,213	$194,685	$167,461	$34,384	$422,744	$23,748	$446,492
792	Prducrs, orch., entertainers	$62,318	$653,097	$2,228,300	$2,068,684	$5,012,399	$568,798	$5,581,198
793	Bowling centers	$26,287	$276,069	$897,600	$420,128	$1,620,084	$204,510	$1,824,594
794	Commercial sports	$26,488	$447,160	$2,257,642	$1,633,293	$4,364,582	$621,889	$4,986,471
799	Misc. recreation services	$220,295	$3,347,796	$17,111,737	$16,460,615	$37,140,443	$5,140,130	$42,280,573
801	Offices of medical doctors	$795,650	$9,257,956	$38,345,670	$18,055,369	$66,454,646	$4,696,759	$71,151,405
802	Dentists offices and clinics	$662,268	$5,591,068	$12,773,339	$1,724,053	$20,750,727	$1,380,162	$22,130,890
803	Osteopathic physicians	$29,011	$296,513	$746,415	$114,295	$1,186,233	$66,915	$1,253,148
804	Other health practitioners	$306,635	$2,833,281	$9,332,064	$3,264,101	$15,736,081	$2,174,376	$17,910,457
805	Nursing & personal care fac.	$82,676	$7,669,934	$47,772,674	$20,940,175	$76,465,458	$18,724,302	$95,189,760
806	Hospitals	$34,732	$17,089,022	$162,738,633	$61,252,553	$241,114,940	$23,055,478	$264,170,417
807	Med. & dental labs	$75,417	$968,029	$4,658,002	$2,441,206	$8,142,653	$526,241	$8,668,894
808	Home hlth care services	$61,518	$2,958,485	$20,377,584	$13,837,536	$37,235,124	$5,503,950	$42,739,074

TABLE VIII-2

Total Cost of Compliance, by Provision of the Final Rule and 3-Digit SIC

SIC	Industry	Determination of Coverage by the Standard and Grandfather Status	Initial Employer Actions	Programmatic Elements	Job Fixes	SUBTOTAL (cost to society)	Work Restriction Protection	TOTAL (cost to employers)
809	Hlth & allied serv., n.e.c.	$89,537	$1,639,130	$9,661,488	$5,018,567	$16,408,721	$1,495,420	$17,904,141
811	Legal services	$865,868	$7,500,019	$17,799,819	$3,180,297	$29,346,004	$1,489,038	$30,835,042
821	Elem. & secondary schools	$96,629	$2,075,207	$12,120,163	$5,030,195	$19,322,194	$978,016	$20,300,210
822	Colleges & universities	$17,833	$3,173,736	$28,871,072	$14,204,017	$46,266,659	$1,400,722	$47,667,382
823	Libraries	$10,322	$112,564	$346,834	$49,032	$518,752	$19,773	$538,525
824	Vocational schools	$30,216	$361,855	$1,218,638	$245,080	$1,855,789	$74,914	$1,930,703
829	Schools, n.e.c.	$69,161	$695,829	$1,895,912	$325,725	$2,986,627	$111,586	$3,098,213
832	Individual & fam. services	$154,198	$2,154,127	$10,986,627	$7,634,074	$20,929,025	$3,130,158	$24,059,183
833	Job train. & related serv.	$29,400	$670,342	$4,432,233	$4,437,946	$9,569,922	$975,169	$10,545,092
835	Child day care services	$163,334	$1,677,069	$6,415,389	$2,415,378	$10,671,170	$1,725,903	$12,397,073
836	Residential care	$94,489	$2,025,851	$11,249,253	$8,010,052	$21,379,646	$4,888,065	$26,267,710
839	Social services, n.e.c.	$55,314	$705,695	$3,366,520	$2,231,129	$6,358,657	$596,245	$6,954,902
841	Museums & art galleries	$18,517	$239,409	$1,183,086	$433,212	$1,874,224	$213,889	$2,088,113
842	Bot. & zoolog. gardens	$2,339	$49,664	$300,060	$252,528	$604,590	$68,789	$673,379
861	Business associations	$82,066	$752,951	$1,998,739	$360,668	$3,194,425	$129,757	$3,324,182
862	Prof. organizations	$33,822	$346,623	$975,849	$154,935	$1,511,229	$51,718	$1,562,948
863	Labor organizations	$58,381	$720,579	$2,122,658	$258,261	$3,159,879	$97,014	$3,256,892
864	Civic & social assoc.	$109,671	$1,554,594	$6,898,349	$2,327,095	$10,889,709	$926,225	$11,815,935
865	Political organizations	$11,821	$99,819	$251,084	$42,249	$404,974	$35,547	$440,520
866	Religious organizations	$661,023	$6,971,356	$17,662,862	$2,235,046	$27,530,288	$483,101	$28,013,389
869	Membership orgs., n.e.c.	$28,367	$435,535	$2,186,591	$1,294,857	$3,945,350	$257,326	$4,202,676
871	Eng. and arch. services	$436,740	$4,977,286	$19,558,333	$6,085,276	$31,057,635	$1,172,366	$32,230,001
872	Accntng, auditng, & bkeeping	$479,769	$4,330,483	$14,187,721	$4,852,167	$23,850,139	$1,078,937	$24,929,076
873	Research & testing services	$99,803	$1,974,139	$12,323,854	$5,138,989	$19,536,785	$1,271,837	$20,808,622
874	Management & pub. relations	$438,214	$4,985,011	$21,062,857	$11,488,746	$37,974,829	$1,900,903	$39,875,732
899	Services, n.e.c.	$80,432	$868,169	$3,130,239	$1,197,299	$5,276,139	$669,565	$5,945,705
	Subtotal	$25,614,221	$417,663,629	$1,882,097,229	$1,089,989,195	$3,415,364,275	$564,442,929	$3,979,807,204
	State & Local Government	$829,715	$36,920,178	$299,429,246	$159,093,322	$496,272,461	$62,264,526	$558,536,987
	TOTAL (inluding government)	$26,443,937	$454,583,807	$2,181,526,475	$1,249,082,518	$3,911,636,736	$626,707,455	$4,538,344,191

Source: OSHA Office of Regulatory Analysis, U.S. Department of Labor

The programmatic elements of the standard have annualized costs of $2.2 billion. In addition, the provision requiring employers to control jobs that have been found to have MSD hazards, has costs of $1.3 billion per year. Four of the industries covered by the standard have costs of more than $100 million per year: hospitals (SIC 806); eating and drinking places (SIC 581); trucking and courier services (SIC 421) and grocery stores (SIC 541).

Estimates of the costs of job controls are presented as net costs, because OSHA has taken the benefits employers often accrue from productivity improvements associated with job controls as offsets to the costs of job control. OSHA estimates that the labor savings (productivity improvements) provided by the job controls the standard will require will amount to approximately $700 million per year in annualized savings.[2] OSHA believes that many ergonomic interventions improve productivity, either because they reduce employee fatigue and relieve muscle pain (which means that the employee will do more work in less time), or because they involve automating portions of jobs in ways that can be expected to improve productivity. In addition to such direct effects on productivity, ergonomic interventions frequently offset the employers' cost for controls by :

• Reducing absenteeism because a worker is less likely to take time off to recover from muscle soreness, fatigue, etc.;

• Reducing turnover, particularly since new hires are more likely to find an ergonomically designed job within their physical capacity;

• Improving product quality because fewer errors are made when processes are more mechanized and demand less physical effort.

These positive productivity impacts are attested to by the experience of many employers (see the productivity tables in Chapter V of the Final Economic Analysis). OSHA's 1993 ergonomics survey of general industry employers found that 30 percent of those employers who had implemented ergonomics controls reported that their ergonomics programs had had measurable positive impacts on productivity. On average, these employers (including the few employers who reported that their controls had negative impacts on productivity) reported a weighted average productivity improvement of 7 percent per ergonomic intervention. The cost estimates presented in this Final Economic Analysis differ appreciably from those presented in the Preliminary Economic Analysis. These changes are described in greater detail in Chapter V of this final analysis, but the most important changes and the reasons for them are the following:

• The inclusion of a clearly defined action trigger in the final standard has served to significantly reduce the costs of the standard. In the preliminary economic analysis, OSHA assumed that all MSDs in jobs that had not yet been fixed would require job controls and other actions as appropriate. Under the final rule (and thus in this final analysis), many reports of MSDs will not trigger further action because they would not meet the standard's screen. Thus the screen serves to significantly reduce the costs of the standard.

• In order to ensure that the economic analysis reflects the costs associated with implementing ergonomics programs in practice, the costs for most program elements have been revised upward to account for the extensive comments in the record on the experience of firms that have implemented ergonomics programs. On the other hand, the estimated costs to general industry employers in establishments that do not have MSDs have been reduced, since the final standard, unlike the proposal, no longer has a requirement for all establishments with manufacturing or manual handling jobs to have a basic program.

• Work restriction protection (WRP) costs are substantially reduced overall, although the per-case costs have been increased. The overall decrease in WRP costs is a result of the reduced length of WRP coverage (from 6 to 3 months) and the effects of the screen; WRP will only be paid under the final rule to workers in jobs that meet the action trigger. In addition, OSHA agrees with comments in the record pointing out that OSHA's preliminary WRP cost estimates did not accurately reflect the full costs to the employer of WRP wage replacement, and the final WRP costs have been adjusted accordingly.

• OSHA's cost estimates in the final rule also take account of the increase in the number of MSDs the Agency believes will be reported to employers as a result of the encouragement to report provided by WRP and the inclusion of persistent signs and symptoms in the standard's definition of an MSD incident.

OSHA has not significantly changed its estimates of the unit costs of job controls since the proposal. OSHA believes, after a review of the comments and cost estimates in the record and an analysis of the controls needed to achieve the final rule's endpoint, that its initial costs-of-control estimates are reasonable.

F. Economic Feasibility (Chapter VI)

The OSH Act requires the Agency to set standards that are feasible, both technologically and economically. To demonstrate that a standard is feasible, the courts have held that OSHA must "construct a reasonable estimate of compliance costs and demonstrate a reasonable likelihood that these costs will not threaten the existence or competitive structure of an industry" [*United Steelworkers of America, AFL–CIO–CLC* v. *Marshall* (the "Lead" decision)], 647 F2d 1189 (DC Cir. 1980).

OSHA's analysis of economic feasibility was conducted on an establishment basis. For each affected industry, estimates of per-establishment annualized compliance costs were compared with per-establishment estimates of revenues and per-establishment estimates of profits, using two worst-case assumptions about the ability of employers to pass the costs of compliance through to their customers: The no cost passthrough assumption and the full cost passthrough assumption. Based on the results of these comparisons, which define the universe of potential impacts of the ergonomics program standard, OSHA then assessed the final standard's economic feasibility for establishments in all covered industries.

OSHA assumed that the establishments falling within the scope of the final standard had the same average sales and profits as other establishments in their industries. This assumption is reasonable because there is no evidence suggesting that the financial characteristics of those firms whose employees experience MSD incidents are different from firms that do not have such incidents among their workforce. Absent such evidence, OSHA relied on the best available financial data (those from the Bureau of the Census (Ex. 28–6) and Robert Morris Associates (Ex. 502–69)), used commonly accepted methodology to calculate industry averages, and based its analysis of the significance of the projected economic impacts and the feasibility of compliance on these data. For this Final Economic Analysis, OSHA averaged profit data for the four years 1995 to 1998 rather than using a single year's data. Because industry profit can show major year-to-year variance, this modification assures that

[2] OSHA estimated productivity impacts by determining the average percentage reduction from gross costs caused by productivity in a set of examples of ergonomic interventions. Please see the Final Economic Analysis, particularly Tables V–17 through V–19, for details.

the results of the analysis will not depend on a single unusually bad or good year for an industry,

The analysis of the potential impacts of the ergonomics program standard on before-tax profits and sales shown in Table VIII–3 is called a screening analysis because it simply measures costs as a percentage of pre-tax profits and sales under the worst-case assumptions discussed above, but does not predict impacts on these before-tax profits or sales. The screening analysis is used to determine whether the compliance costs potentially associated with the final standard could lead to significant impacts on all establishments. The actual impact of the final standard on the profit and sales of establishments in a given industry will depend on the price elasticity of demand for the products or services of establishments in that industry.

Table VIII–3 shows that the potential impacts of the final standard on average industry profits are small, even under the worst-case scenario of no cost passthrough. For all industries as a whole, annualized compliance costs are 0.5 percent of profits. Compliance costs do not exceed 5 percent of profits in any industry.

Based on the data for establishments in all industries shown in Table VIII–3, OSHA concludes that the ergonomics program standard is economically feasible for the establishments covered by the standard. OSHA reaches this conclusion based on the fact that, even under the worst case scenario of full cost passthrough, impacts on average industry revenues are only 0.02 percent and under the worst case scenario of no cost passthrough, impacts on average profits are only 0.5 percent, with no industry having impacts on profit of greater than 5 percent.

OSHA's Final Economic Analysis also examined impacts for those establishments most likely to be affected by the standard as a result of having MSD hazards, and found the standard was feasible for these establishments as well. (See Chapter VI of the Final Economic Analysis)

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Table VIII-3 Screening Analysis of the Potential Impacts of the Ergonomics Program Standard on All Industries Under Worst-Case Assumptions

						For All Establishments		
SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Annualized Compliance Cost per Establishment
074	Veterinary services	$6,626,074	$7,693,839	6.1%	$472,228	0.09%	1.4%	$291
075	Animal serv., excpt vet.	$1,406,462	$1,821,371	6.0% [d]	$109,619	0.08%	1.3%	$136
078	Lndscape & hort. services	$26,019,201	$19,389,342	5.9%	$1,136,422	0.13%	2.3%	$382
081	Timber tracts	$524,389	$851,843	10.3% [d]	$87,740	0.06%	0.6%	$608
083	Forest products	$151,696	$247,111	10.3% [d]	$25,452	0.06%	0.6%	$1,111
085	Forestry services	$716,085	$1,069,094	10.3% [d]	$110,117	0.07%	0.7%	$457
091	Commerical fishing	$631,759	$1,343,245	5.7% [d]	$77,142	0.05%	0.8%	$324
092	Fish hatcheries	$93,972	$62,473	6.1% [d]	$3,833	0.15%	2.5%	$985
097	Hunting & trapping	$109,451	$167,605	6.1% [d]	$10,282	0.07%	1.1%	$323
131	Crude petrol. & nat. gas	$4,247,294	$59,652,592	8.7%	$5,159,949	0.01%	0.1%	$547
132	Natural gas liquids	$206,046	$41,021,720	8.7% [d]	$3,548,379	0.00%	0.0%	$368
138	Oil & gas field services	$8,821,401	$9,630,581	8.7%	$833,045	0.09%	1.1%	$1,007
201	Meat products	$16,336,248	$117,204,932	2.6%	$2,992,729	0.01%	0.5%	$5,304
202	Dairy products	$7,181,176	$59,676,113	3.4%	$2,051,157	0.01%	0.4%	$3,818
203	Presrvd fruits & vegetables	$5,714,289	$47,486,808	4.0%	$1,893,073	0.01%	0.3%	$2,834
204	Grain mill products	$6,256,889	$55,960,493	3.3%	$1,847,864	0.01%	0.3%	$2,404
205	Bakery products	$11,227,192	$31,963,430	3.7%	$1,173,991	0.04%	1.0%	$3,187
206	Sugar and confect. prods	$4,355,561	$22,593,884	3.6%	$821,090	0.02%	0.5%	$3,967
207	Fats and oils	$1,295,550	$21,732,140	3.5% [d]	$752,684	0.01%	0.2%	$2,555
208	Beverages	$9,153,043	$64,480,420	4.7% [e]	$3,055,948	0.01%	0.3%	$4,004
209	Misc. food products	$8,811,830	$37,957,910	3.1% [e]	$1,188,055	0.02%	0.7%	$2,199
211	Cigarettes	$911,979	$25,695,548	4.0% [d]	$1,032,237	0.00%	0.1%	$60,799
212	Cigars	$110,012	$315,743	4.0% [d]	$12,684	0.03%	0.9%	$2,341
213	Chewing & smoking tobacco	$141,473	$1,544,972	4.0% [d]	$62,064	0.01%	0.2%	$5,441
214	Tobacco stemm. & redrying	$260,642	$3,104,375	4.0% [d]	$124,708	0.01%	0.2%	$8,145
221	Brdwven fab. mills, cotton	$1,729,877	$6,018,357	4.0%	$237,725	0.03%	0.7%	$4,199
222	Broadwoven fabric mills	$2,772,508	$9,703,013	2.8% [e]	$268,592	0.03%	1.0%	$6,054
223	Brdwvn fab. mills, wool	$423,249	$1,720,695	2.8% [e]	$47,631	0.02%	0.9%	$4,275
224	Narrow fabric mills	$793,599	$1,485,068	3.2%	$47,151	0.05%	1.7%	$2,865
225	Knitting mills	$6,557,074	$17,214,105	2.9%	$494,169	0.04%	1.3%	$3,371
226	Tex. finishing, excpt wool	$2,078,849	$7,498,188	2.8%	$210,230	0.03%	1.0%	$2,440
227	Carpets and rugs	$1,845,579	$12,446,310	2.8%	$345,385	0.01%	0.5%	$3,813
228	Yarn and thread mills	$2,939,788	$12,173,797	2.0%	$239,351	0.02%	1.2%	$5,000
229	Misc. textile goods	$2,411,461	$8,817,910	2.8% [e]	$248,393	0.03%	1.0%	$2,388
231	Men's & boys' suits & coats	$818,300	$1,906,167	0.9% [e]	$17,632	0.04%	4.6%	$2,793
232	Men's & boys' furnishings	$6,959,053	$15,125,809	2.7%	$410,792	0.05%	1.7%	$3,295
233	Wm's & misses' outerwear	$6,423,694	$19,500,842	2.6%	$503,021	0.03%	1.3%	$717
234	Wm's & chldrn's undergarmnts	$1,050,167	$2,918,268	2.4% [e]	$70,461	0.04%	1.5%	$2,823
235	Hats, caps, & millinery	$576,448	$1,098,786	3.9%	$43,127	0.05%	1.3%	$1,513
236	Girls' & chldrn's outerwear	$815,446	$2,258,886	2.0%	$44,601	0.04%	1.8%	$1,394
237	Fur goods	$26,422	$142,828	2.6%	$3,654	0.02%	0.7%	$199
238	Misc. apparel & accessories	$998,257	$2,244,834	2.6% [e]	$57,685	0.04%	1.7%	$1,070
239	Misc. fab. textile prods	$7,526,231	$22,070,600	2.6%	$576,033	0.03%	1.3%	$856
241	Logging	$2,375,425	$15,538,413	3.9% [f]	$605,840	0.02%	0.4%	$166
242	Sawmills & planing mills	$8,394,106	$25,776,399	4.3%	$1,107,058	0.03%	0.8%	$1,375
243	Millwork & plywood	$15,367,887	$31,414,582	3.6%	$1,131,630	0.05%	1.4%	$1,610
244	Wood containers	$2,187,909	$4,006,433	3.7%	$146,701	0.05%	1.5%	$773
245	Wood bldings & mobile homes	$5,387,771	$12,663,722	3.8%	$475,846	0.04%	1.1%	$5,161
249	Misc. wood products	$4,587,760	$13,133,205	3.9% [e]	$508,993	0.03%	0.9%	$1,297
251	Household furniture	$13,563,894	$24,242,412	3.2%	$775,683	0.06%	1.7%	$2,466
252	Office furniture	$3,869,704	$9,836,788	3.8%	$377,227	0.04%	1.0%	$3,746
253	Pub blding & related furn.	$2,961,832	$6,139,247	4.1%	$250,174	0.05%	1.2%	$6,597
254	Partitions and fixtures	$4,771,304	$8,109,037	3.7%	$301,202	0.06%	1.6%	$1,593
259	Misc furniture and fixtures	$2,079,483	$4,857,016	3.2%	$153,079	0.04%	1.4%	$1,473
261	Pulp mills	$657,339	$5,810,924	4.5%	$261,545	0.01%	0.3%	$10,602
262	Paper mills	$7,693,243	$35,582,333	4.8% [e]	$1,690,161	0.02%	0.5%	$22,364
263	Paperboard mills	$2,674,347	$19,899,897	4.5% [d]	$895,679	0.01%	0.3%	$11,730
265	Paperbrd containers & boxes	$11,927,157	$40,019,006	4.6%	$1,829,035	0.03%	0.7%	$4,246
267	Misc. cnvrtd paper products	$13,220,823	$49,954,537	4.3%	$2,150,381	0.03%	0.6%	$4,359
271	Newspapers	$18,766,157	$37,006,756	3.8% [d]	$1,406,082	0.05%	1.3%	$2,114
272	Periodicals	$3,995,497	$26,525,283	3.8%	$1,007,961	0.02%	0.4%	$691
273	Books	$5,832,617	$26,774,751	4.5% [e]	$1,199,979	0.02%	0.5%	$1,639
274	Miscellaneous publishing	$2,255,167	$10,624,468	4.5%	$475,445	0.02%	0.5%	$692
275	Commercial printing	$27,882,271	$66,006,851	3.4%	$2,272,949	0.04%	1.2%	$810
276	Manifold business forms	$2,482,368	$7,941,418	3.4%	$266,038	0.03%	0.9%	$2,725
277	Greeting cards	$1,272,733	$4,434,535	3.8% [d]	$168,491	0.03%	0.8%	$8,900
278	Blankbooks & bookbinding	$3,314,599	$5,222,155	3.9%	$205,657	0.06%	1.6%	$2,094
279	Printing trade services	$2,018,486	$4,984,730	3.6% [e]	$178,485	0.04%	1.1%	$587
281	Indust. inorganic chemicals	$3,508,720	$30,002,480	4.5% [e]	$1,348,616	0.01%	0.3%	$2,524
282	Plastics mat. & synthetics	$4,388,299	$57,333,971	4.5%	$2,577,543	0.01%	0.2%	$5,009
283	Drugs	$8,245,601	$98,347,315	4.8%	$4,707,405	0.01%	0.2%	$5,037
284	Soap, clnrs, & toilet goods	$4,973,167	$48,294,820	4.4%	$2,125,571	0.01%	0.2%	$2,043
285	Paints & allied products	$2,085,227	$17,587,225	3.8%	$659,521	0.01%	0.3%	$1,410
286	Indust. organic chemicals	$4,966,241	$79,254,515	4.5%	$3,556,542	0.01%	0.1%	$5,250
287	Agricultural chemicals	$1,506,510	$22,569,700	3.8%	$851,285	0.01%	0.2%	$1,606
289	Misc. chemical products	$3,754,194	$27,864,576	4.8% [e]	$1,325,428	0.01%	0.3%	$1,463
291	Petroleum refining	$3,824,084	$145,808,878	2.9%	$4,155,553	0.00%	0.1%	$13,906
295	Asphlt pavng & roofng mat.	$1,742,001	$9,765,070	3.9%	$382,554	0.02%	0.5%	$1,273

Table VIII-3 Screening Analysis of the Potential Impacts of the Ergonomics Program Standard on All Industries Under Worst-Case Assumptions

	SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	For All Establishments: Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Annualized Compliance Cost per Establishment
	299	Misc. pet. & coal prods	$595,662	$6,900,468	4.7%	$326,979	0.01%	0.2%	$1,278
	301	Tires and inner tubes	$3,700,877	$12,649,425	4.0% [d]	$509,114	0.03%	0.7%	$21,643
	302	Rubber & plastics footwear	$321,216	$688,879	4.0% [d]	$27,726	0.05%	1.2%	$5,266
	305	Hose, bltng, and gaskets	$2,925,345	$8,004,186	4.0%	$319,914	0.04%	0.9%	$3,542
	306	Fab. rubber prod., n.e.c.	$5,477,509	$13,765,033	4.0%	$554,015	0.04%	1.0%	$3,100
	308	Misc plastics, n.e.c.	$32,524,105	$106,907,067	4.0%	$4,305,065	0.03%	0.8%	$2,383
	311	Leather tan. & finishing	$883,110	$2,738,038	1.7%	$47,231	0.03%	1.9%	$2,575
	313	Footwear cut stock	$100,992	$213,944	2.2% [d]	$4,700	0.05%	2.1%	$1,443
	314	Footwear, except rubber	$2,001,936	$3,634,490	2.3%	$85,181	0.06%	2.4%	$5,296
	315	Leather gloves & mittens	$133,700	$149,789	2.2% [d]	$3,290	0.09%	4.1%	$1,938
	316	Luggage	$356,297	$1,007,874	2.9%	$29,480	0.04%	1.2%	$1,365
	317	Hndbags & prsnal leathr gds.	$401,849	$848,276	2.2% [d]	$18,635	0.05%	2.2%	$1,172
	319	Leather goods, n.e.c.	$440,533	$651,426	2.2% [f]	$14,310	0.07%	3.1%	$1,054
	321	Flat glass	$979,004	$2,709,081	4.9% [d]	$133,468	0.04%	0.7%	$12,086
	322	Glass, pressed or blown	$4,176,490	$9,244,687	4.9% [f]	$455,456	0.05%	0.9%	$7,091
	323	Prod. of purchased glass	$3,651,089	$9,109,494	5.1%	$460,029	0.04%	0.8%	$2,226
	324	Cement, hydraulic	$903,547	$4,720,190	4.9% [d]	$232,549	0.02%	0.4%	$3,911
	325	Structural clay products	$1,805,854	$3,232,723	5.4%	$174,042	0.06%	1.0%	$3,045
	326	Pottery & related prods	$2,456,424	$3,370,197	4.9% [d]	$166,039	0.07%	1.5%	$2,047
	327	Concrete & plast. prdcts	$11,006,283	$29,948,845	4.8%	$1,446,026	0.04%	0.8%	$1,159
	328	Cut stone & stone prods	$848,181	$1,218,989	5.0%	$61,254	0.07%	1.4%	$792
	329	Misc. nonmet. mineral prods.	$3,786,458	$12,831,147	5.0% [e]	$635,442	0.03%	0.6%	$2,368
	331	Basic steel products	$12,391,187	$69,010,676	4.3%	$2,971,554	0.02%	0.4%	$9,650
	332	Iron and steel foundries	$7,727,050	$15,484,686	4.6%	$705,495	0.05%	1.1%	$6,661
	333	Primary nonfer. metals	$1,718,779	$17,465,720	4.5% [d]	$789,048	0.01%	0.2%	$8,551
	334	Secondary nonfer. metals	$838,630	$7,521,366	3.9%	$291,453	0.01%	0.3%	$2,805
	335	Nonfer. rolling & drawing	$8,018,138	$45,476,554	4.9%	$2,211,228	0.02%	0.4%	$7,256
	336	Nonfer. foundries (cstngs)	$4,713,869	$9,611,068	4.5%	$432,061	0.05%	1.1%	$2,836
	339	Misc. primary metal prdcts	$1,331,479	$4,169,927	4.8%	$201,967	0.03%	0.7%	$1,406
	341	Met. cans & ship. containers	$1,885,553	$13,004,892	4.1%	$527,097	0.01%	0.4%	$4,335
	342	Cutlery, hndtls, & hardware	$6,825,191	$17,122,208	4.6% [e]	$789,478	0.04%	0.9%	$2,790
	343	Plumbing & heating fixtures	$2,996,991	$7,375,857	4.8%	$351,921	0.04%	0.9%	$4,356
	344	Fab. struct. metal prdcts	$22,004,754	$56,840,749	4.3%	$2,434,529	0.04%	0.9%	$1,650
	345	Screw machine products	$5,146,027	$11,596,795	4.4%	$512,803	0.04%	1.0%	$1,978
	346	Met. forgings & stampings	$15,669,434	$40,752,728	4.6%	$1,860,834	0.04%	0.8%	$4,242
	347	Metal services, n.e.c.	$5,827,182	$12,900,758	5.0%	$638,665	0.05%	0.9%	$1,054
	348	Ordnance and access., n.e.c.	$1,814,240	$4,686,212	4.5% [d]	$213,041	0.04%	0.9%	$4,142
	349	Misc. fab. metal products	$14,624,727	$38,754,246	4.9%	$1,896,544	0.04%	0.8%	$2,013
	351	Engines and turbines	$4,114,400	$16,985,636	4.0% [d]	$687,199	0.02%	0.6%	$11,090
	352	Farm & garden machinery	$5,547,056	$17,677,144	4.7%	$835,521	0.03%	0.7%	$3,150
	353	Construct. & related mach.	$10,256,663	$33,857,157	4.3%	$1,464,223	0.03%	0.7%	$3,086
	354	Metalworking machinery	$14,909,924	$34,863,234	4.6%	$1,600,454	0.04%	0.9%	$1,262
	355	Special industry mach.	$8,962,105	$29,950,693	4.1%	$1,215,684	0.03%	0.7%	$1,871
	356	General indust. mach.	$12,635,827	$38,890,135	4.3%	$1,688,021	0.03%	0.7%	$2,886
	357	Computer & office equip.	$8,888,477	$72,679,343	3.3%	$2,392,918	0.01%	0.4%	$4,209
	358	Refrig. & serv. indust mach.	$10,731,185	$36,688,548	3.6%	$1,318,603	0.03%	0.8%	$4,778
	359	Industrial mach., n.e.c.	$17,581,643	$35,100,649	5.1% [e]	$1,775,325	0.05%	1.0%	$679
	361	Elect. dist. equipment	$2,490,937	$11,273,986	5.2%	$583,158	0.02%	0.4%	$2,847
	362	Elect. indust. apparatus	$6,362,629	$21,854,697	5.1%	$1,123,278	0.03%	0.6%	$2,815
	363	Household appliances	$4,847,685	$21,300,973	5.6% [d]	$1,191,009	0.02%	0.4%	$10,227
	364	Elct. lghtng & wire equip.	$6,061,735	$23,289,566	5.7%	$1,334,823	0.03%	0.5%	$2,863
	365	Household audio & vid. equip.	$1,817,780	$13,716,113	5.0%	$689,969	0.01%	0.3%	$2,230
	366	Communications equipment	$7,548,252	$57,675,808	5.8% [e]	$3,319,137	0.01%	0.2%	$3,577
	367	Electrnic compnnts & access.	$16,948,945	$103,870,202	5.6%	$5,795,165	0.02%	0.3%	$2,580
	369	Misc. elect. equipment	$6,129,975	$26,674,704	5.9% [e]	$1,571,284	0.02%	0.4%	$3,428
	371	Motor vehicles & equipt.	$47,559,830	$339,576,992	3.5%	$11,890,177	0.01%	0.4%	$9,420
	372	Aircraft and parts	$16,172,006	$93,016,989	4.7% [e]	$4,339,753	0.02%	0.4%	$9,552
[a]	373	Ship, boat blding and repair	$4,325,288	$6,028,640	3.6%	$219,574	0.07%	2.0%	$1,616
	374	Railroad equipment	$1,401,806	$6,654,526	3.7%	$244,554	0.02%	0.6%	$6,581
	375	Motorcycles & bicycles	$728,294	$3,336,172	3.7%	$124,877	0.02%	0.6%	$1,968
	376	Guided missiles	$2,376,442	$18,052,173	3.7%	$675,714	0.01%	0.4%	$22,633
	379	Misc. transportation equip.	$1,927,471	$8,420,402	3.7% [e]	$307,940	0.02%	0.6%	$1,698
	381	Srch & navigation equipment	$5,330,824	$30,132,161	4.7% [e]	$1,416,212	0.02%	0.4%	$7,659
	382	Meas. & contrlling devices	$9,112,747	$39,725,944	5.6%	$2,230,765	0.02%	0.4%	$1,916
	384	Medical instrmnts & supplies	$8,892,440	$49,607,297	5.3% [e]	$2,635,490	0.02%	0.3%	$1,989
	385	Ophthalmic goods	$882,740	$2,850,267	3.7%	$104,747	0.03%	0.8%	$1,504
	386	Photo. equip. & supplies	$2,432,719	$19,103,716	4.0%	$764,149	0.01%	0.3%	$3,374
	387	Watches, clocks, & parts	$160,640	$768,223	5.1% [d]	$38,879	0.02%	0.4%	$1,139
	391	Jwlry, slvrwre, and plate	$1,545,211	$6,261,321	3.3%	$208,466	0.02%	0.7%	$549
	393	Musical instruments	$603,803	$1,313,948	3.8% [d]	$49,986	0.05%	1.2%	$1,098
	394	Toys and sporting goods	$4,651,691	$14,422,948	3.7%	$527,830	0.03%	0.9%	$1,323
	395	Office and art supplies	$998,400	$3,683,197	3.8% [d]	$140,117	0.03%	0.7%	$962
	396	Costume jewelry & notions	$672,112	$2,246,891	3.8% [d]	$85,477	0.03%	0.8%	$615
	399	Misc. manufactures	$6,687,609	$19,008,990	4.1%	$773,665	0.04%	0.9%	$760
	411	Local & suburban trans.	$18,525,193	$8,742,145	4.4%	$384,558	0.21%	4.8%	$1,943
	412	Taxicabs	$1,632,576	$1,286,889	4.5% [d]	$58,011	0.13%	2.8%	$494
	413	Intercty & rural bus trans.	$2,001,297	$1,610,701	5.4%	$86,575	0.12%	2.3%	$4,161
	414	Bus charter service	$1,485,827	$1,653,193	4.6%	$75,976	0.09%	2.0%	$1,038

Table VIII-3 Screening Analysis of the Potential Impacts of the Ergonomics Program Standard on All Industries Under Worst-Case Assumptions

SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	For All Establishments: Annualized Compliance Costs as a Percentage of Revenues	For All Establishments: Annualized Compliance Costs as a Percentage of Profits	For All Establishments: Annualized Compliance Cost per Establishment
415	School buses	$7,856,261	$4,192,484	4.6%	$190,758	0.19%	4.1%	$1,849
417	Bus terminals	$40,656	$44,464	4.5% [d]	$2,004	0.09%	2.0%	$713
421	Trking & Courier Service	$163,308,208	$169,408,687	3.4%	$5,825,289	0.10%	2.8%	$1,397
422	Pub. warehousing & storage	$12,659,274	$11,696,021	10.7%	$1,246,682	0.11%	1.0%	$1,068
423	Trucking terminal fac.	$93,603	na *	3.9% [d]	na	na	na	$1,170
430	U.S. Postal Service	$59,215,160	$56,600,000	na	na	0.10%	na	$1,777
451	Air trans., scheduled	$78,440,368	$139,896,879	3.6% x	$4,977,185	0.06%	1.6%	$11,871
452	Air trans., nonsched.	$1,608,760	$4,596,451	5.3%	$243,612	0.04%	0.7%	$879
458	Airports and services	$8,187,010	$9,429,735	3.8%	$360,687	0.09%	2.3%	$2,040
461	Pipelines, excpt natural gas	$1,573,705	$8,949,097	6.5% [d]	$585,965	0.02%	0.3%	$1,634
472	Pass. trans. arrangements	$4,712,700	$14,855,776	2.4%	$360,683	0.03%	1.3%	$142
473	Freight trans. arrangements	$9,070,991	$13,557,555	3.9%	$521,966	0.07%	1.7%	$614
474	Rental of railroad cars	$99,116	$2,475,148	3.4% [d]	$83,933	0.00%	0.1%	$854
478	Misc. trans. services	$3,543,768	$3,112,064	5.4%	$168,489	0.11%	2.1%	$1,322
481	Telephone communication	$25,297,052	$208,432,617	5.9%	$12,368,636	0.01%	0.2%	$927
482	Telegrph & other comm.	$125,668	$1,436,935	5.6% [f]	$80,168	0.01%	0.2%	$270
483	Radio & TV broadcasting	$2,992,791	$35,250,634	6.6%	$2,327,550	0.01%	0.1%	$339
484	Cable & othr pay TV services	$4,980,102	$43,809,951	2.7%	$1,193,821	0.01%	0.4%	$1,041
489	Communication serv., n.e.c.	$311,015	$5,631,490	6.1%	$343,521	0.01%	0.1%	$209
491	Electric services	$12,634,563	$162,448,596	12.5%	$20,251,925	0.01%	0.1%	$2,013
492	Gas product. & distribution	$5,105,696	$89,523,533	7.9%	$7,055,407	0.01%	0.1%	$1,296
493	Comb. utility services	$5,571,120	$71,542,818	10.4% [d]	$7,422,386	0.01%	0.1%	$2,978
494	Water supply	$1,063,552	$4,130,669	12.2%	$504,974	0.03%	0.2%	$287
495	Sanitary services	$7,251,426	$24,057,028	6.2%	$1,503,468	0.03%	0.5%	$1,117
496	Steam & air-cond. supplies	$35,821	$434,948	10.4% [d]	$45,125	0.01%	0.1%	$519
497	Irrigation systems	$54,670	$167,025	10.4% [d]	$17,328	0.03%	0.3%	$149
501	Motor vehicles	$32,754,703	$510,238,863	2.2%	$11,173,893	0.01%	0.3%	$715
502	Furn. & homefurnishings	$11,501,256	$68,862,490	2.3%	$1,572,923	0.02%	0.7%	$689
503	Lumber & construct. mat.	$22,645,424	$117,970,381	2.3%	$2,715,347	0.02%	0.8%	$956
504	Prof. & commercial equip.	$40,224,535	$329,207,483	2.7%	$8,987,745	0.01%	0.4%	$774
505	Met. & minerals, excpt pet.	$11,399,553	$151,787,907	2.6%	$3,921,078	0.01%	0.3%	$999
506	Electrical goods	$26,119,207	$337,183,776	2.5%	$8,455,255	0.01%	0.3%	$626
507	Hardware supplies	$20,028,215	$95,859,741	2.5%	$2,410,903	0.02%	0.8%	$767
508	Mach., equipt, & supplies	$50,767,296	$293,593,950	2.9%	$8,469,609	0.02%	0.6%	$666
509	Misc. durable goods	$20,696,753	$183,194,901	3.0% [e]	$5,446,333	0.01%	0.4%	$517
511	Paper and paper products	$15,282,832	$132,104,428	1.9%	$2,551,991	0.01%	0.6%	$817
512	Drugs, propriet., & sundries	$10,582,855	$194,538,527	3.6% [e]	$6,954,752	0.01%	0.2%	$1,447
513	Apparel and notions	$11,134,655	$125,178,134	2.5%	$3,102,437	0.01%	0.4%	$512
514	Groceries & related products	$66,340,179	$587,575,642	1.8%	$10,387,601	0.01%	0.6%	$1,532
515	Farm-prod. raw materials	$3,041,440	$141,454,588	28.3%	$40,069,484	0.00%	0.0%	$285
516	Chemicals & allied prods	$9,494,525	$170,707,220	3.1%	$5,263,714	0.01%	0.2%	$626
517	Petrol. & petrol. prods	$8,487,200	$315,300,716	1.3%	$4,022,765	0.00%	0.2%	$644
518	Beer, wine, & dist. bev.	$13,663,221	$70,906,318	3.5%	$2,493,147	0.02%	0.5%	$2,703
519	Misc. nondurable goods	$28,870,656	$218,636,094	2.3%	$5,051,977	0.01%	0.6%	$531
521	Lumber & other blding mat.	$34,967,693	$94,882,400	2.3%	$2,182,295	0.04%	1.6%	$1,441
523	Paint, glass, wallpaper strs	$3,297,530	$7,137,672	2.3%	$160,598	0.05%	2.1%	$337
525	Hardware stores	$5,989,715	$11,768,982	2.2%	$253,033	0.05%	2.4%	$419
526	Retail nurseries and gardens	$5,248,128	$8,246,165	2.5% [e]	$202,031	0.06%	2.6%	$466
527	Mobile home dealers	$3,490,941	$12,128,180	3.2%	$391,134	0.03%	0.9%	$730
531	Department stores	$89,098,598	$212,202,049	2.8%	$5,941,657	0.04%	1.5%	$8,232
533	Variety stores	$6,476,122	$7,801,344	3.1%	$241,842	0.08%	2.7%	$597
539	Misc. gen. merchandise strs.	$12,152,733	$73,078,703	2.2%	$1,607,731	0.02%	0.8%	$821
541	Grocery stores	$134,778,259	$413,038,161	1.4%	$5,576,015	0.03%	2.4%	$1,044
542	Meat and fish markets	$2,349,305	$5,620,494	2.5%	$140,512	0.04%	1.7%	$299
543	Fruit & vegetable markets	$672,801	$2,467,380	1.4% [d]	$34,809	0.03%	1.9%	$201
544	Candy, nut, & confctnry strs	$874,089	$1,508,092	4.1%	$61,455	0.06%	1.4%	$184
545	Dairy products stores	$408,085	$746,400	1.4% [d]	$10,530	0.05%	3.9%	$160
546	Retail bakeries	$5,047,340	$5,837,642	3.2%	$186,805	0.09%	2.7%	$250
549	Misc. food stores	$1,727,223	$4,903,987	2.4%	$116,470	0.04%	1.5%	$174
551	New and used car dealers	$60,977,634	$473,713,203	1.2% [e]	$5,802,987	0.01%	1.1%	$2,475
552	Used car dealers	$1,891,804	$26,046,018	2.5%	$638,127	0.01%	0.3%	$86
553	Auto & home supply stores	$20,999,213	$41,415,750	2.3%	$942,208	0.05%	2.2%	$479
554	Gas service stations	$24,394,488	$154,592,503	1.6%	$2,473,480	0.02%	1.0%	$253
555	Boat dealers	$2,291,931	$7,697,095	2.0%	$150,093	0.03%	1.5%	$452
556	Rec. vehicle dealers	$2,217,094	$9,355,689	2.1%	$191,792	0.02%	1.2%	$740
557	Motorcycle dealers	$464,370	$6,487,093	2.8%	$181,639	0.01%	0.3%	$123
559	Auto dealers, n.e.c.	$126,679	$1,290,175	2.6% [e]	$33,545	0.01%	0.4%	$103
561	Men's & boys' clothing strs	$2,136,535	$9,985,692	1.4%	$137,303	0.02%	1.6%	$154
562	Women's clothing stores	$6,192,802	$29,323,315	1.1%	$322,556	0.02%	1.9%	$153
563	Wm's access.& specialty strs	$1,027,638	$4,417,649	1.8% [d]	$81,580	0.02%	1.3%	$119
564	Chldrn's & infants' wear strs	$1,153,818	$4,249,583	1.8% [d]	$78,477	0.03%	1.5%	$222
565	Family clothing stores	$14,203,805	$40,135,206	2.2%	$862,907	0.04%	1.6%	$725
566	Shoe stores	$5,537,339	$18,686,566	2.4%	$453,149	0.03%	1.2%	$174
569	Misc. apparel stores	$935,244	$4,848,422	2.0%	$96,968	0.02%	1.0%	$92
571	Furnitre & homefurnishng strs	$32,655,674	$63,978,206	2.4%	$1,564,569	0.05%	2.1%	$495
572	Household appliance strs	$5,085,868	$10,491,658	2.2%	$233,439	0.05%	2.2%	$506
573	Radio, TV, & comptr strs	$13,918,160	$59,843,357	2.1%	$1,268,471	0.02%	1.1%	$356
581	Eating & drinking places	$169,794,005	$253,760,234	3.0%	$7,608,776	0.07%	2.2%	$364

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						For All Establishments		
SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Annualized Compliance Cost per Establishment
591	Drug stores	$18,648,665	$91,701,331	2.2%	$1,994,504	0.02%	0.9%	$431
592	Liquor stores	$1,851,269	$21,457,553	1.6%	$337,956	0.01%	0.5%	$64
593	Used merchandise stores	$5,256,032	$7,863,561	4.8%	$379,417	0.07%	1.4%	$223
594	Misc. shopping goods strs.	$32,314,677	$86,940,718	2.6%	$2,295,237	0.04%	1.4%	$250
596	Nonstore retailers	$25,407,770	$71,726,499	2.5%	$1,784,319	0.04%	1.4%	$848
598	Fuel dealers	$5,259,158	$17,012,865	1.8%	$312,317	0.03%	1.7%	$465
599	Retail stores, n.e.c.	$13,833,591	$39,343,051	3.2%	$1,268,653	0.04%	1.1%	$145
601	Central res. depository	$531,574	$34,398,950	10.8% [d]	$3,715,087	0.00%	0.0%	$5,212
602	Commercial banks	$25,779,253	$362,240,850	10.8% [d]	$39,122,012	0.01%	0.1%	$382
603	Savings institutions	$4,331,547	$86,099,788	10.8% [d]	$9,298,777	0.01%	0.0%	$269
606	Credit unions	$3,002,681	$28,386,945	10.8% [d]	$3,065,790	0.01%	0.1%	$201
608	Foreign banking	$355,986	$85,523,610	10.8% [d]	$9,236,550	0.00%	0.0%	$543
609	Banking-related functions	$1,528,544	$17,268,075	10.8% [d]	$1,864,952	0.01%	0.1%	$263
611	Federal credit agencies	$376,512	$27,976,840	10.8%	$3,021,499	0.00%	0.0%	$282
614	Personal cred. institutions	$2,942,012	$69,321,834	15.5% [d]	$10,721,777	0.00%	0.0%	$155
615	Business cred. institutions	$2,261,122	$54,425,294	17.1% [d]	$9,292,417	0.00%	0.0%	$422
616	Mortgage bankers & brokers	$4,635,274	$28,664,554	11.7%	$3,340,580	0.02%	0.1%	$212
621	Security brokers & dealers	$8,719,776	$136,415,141	12.8%	$17,415,666	0.01%	0.1%	$342
622	Commodity contracts brokers	$224,162	$2,902,031	13.3%	$386,418	0.01%	0.1%	$138
623	Security & commod. exchanges	$187,861	$1,424,656	13.3%	$189,699	0.01%	0.1%	$1,606
628	Security & commod. services	$3,311,965	$30,330,543	15.3% [d]	$4,647,281	0.01%	0.1%	$183
631	Life insurance	$12,355,467	$402,471,102	6.8% [d]	$27,462,003	0.00%	0.0%	$1,051
632	Medical & health insur.	$7,921,501	$225,866,321	3.6%	$8,146,743	0.00%	0.1%	$2,374
633	Fire, marine, & caslty ins.	$15,981,462	$304,968,860	9.1% [d]	$27,599,682	0.01%	0.1%	$785
635	Surety insurance	$247,936	$5,184,734	6.8%	$353,772	0.00%	0.1%	$428
636	Title insurance	$1,019,228	$5,360,463	4.6%	$243,901	0.02%	0.4%	$400
637	Pension and health funds	$757,546	$1,884,439	6.8% [f]	$128,582	0.04%	0.6%	$276
639	Ins. carriers, n.e.c.	$97,321	$810,377	6.8%	$55,295	0.01%	0.2%	$333
641	Insurance agents	$16,685,126	$67,001,357	6.8% [d]	$4,572,843	0.02%	0.4%	$131
651	Real estate operators	$18,693,068	$89,035,697	14.1% [d]	$12,527,641	0.02%	0.1%	$186
653	RE agents and managers	$22,419,049	$72,786,929	13.2%	$9,626,071	0.03%	0.2%	$180
654	Title abstract offices	$725,371	$2,702,283	13.3% [e]	$359,659	0.03%	0.2%	$140
655	Subdividers & developrs	$4,539,996	$17,073,624	10.6%	$1,811,322	0.03%	0.3%	$245
671	Holding offices	$4,342,164	$49,468,775	25.4%	$12,557,559	0.01%	0.0%	$453
672	Investment offices	$608,512	$12,829,710	20.4%	$2,620,925	0.00%	0.0%	$661
673	Trusts	$1,558,865	$12,102,680	24.3%	$2,940,648	0.01%	0.1%	$176
679	Miscellaneous investing	$1,674,469	$23,366,830	21.5%	$5,033,629	0.01%	0.0%	$199
701	Hotels and motels	$61,674,948	$85,827,743	7.0%	$5,965,028	0.07%	1.0%	$1,363
702	Rooming & boarding houses	$139,743	$427,076	7.0%	$29,727	0.03%	0.5%	$86
703	Camps and rec. vehicle parks	$420,606	$2,820,658	7.3%	$206,909	0.01%	0.2%	$57
704	Membership-basis org. hotels	$202,861	$762,685	7.0% [d]	$53,087	0.03%	0.4%	$84
721	Laundry & garment srvices	$20,600,413	$19,968,307	5.9%	$1,184,345	0.10%	1.7%	$363
722	Photo studios, portrait	$2,049,535	$4,360,841	4.5% [d]	$196,238	0.05%	1.0%	$156
723	Beauty shops	$5,627,412	$11,597,696	4.4%	$510,299	0.05%	1.1%	$69
724	Barber shops	$654,847	$488,787	5.9%	$28,619	0.13%	2.3%	$146
725	Shoe repair	$300,268	$280,028	5.9%	$16,396	0.11%	1.8%	$135
726	Fun. service and crematories	$2,666,361	$8,817,707	7.6% [d]	$665,737	0.03%	0.4%	$169
729	Misc personal services.	$3,091,259	$6,849,595	6.6% [d]	$449,621	0.05%	0.7%	$101
731	Advertising	$7,680,146	$28,132,776	3.9%	$1,098,079	0.03%	0.7%	$391
732	Credit report.& collection	$2,726,767	$8,373,157	5.4%	$454,864	0.03%	0.6%	$394
733	Mailing, reprod, steno., serv	$10,279,680	$26,231,013	4.7%	$1,237,656	0.04%	0.8%	$293
734	Services to buildings	$21,818,569	$24,230,046	3.5%	$853,530	0.09%	2.6%	$333
735	Misc. equipt. rental	$9,546,733	$30,369,885	8.8%	$2,686,091	0.03%	0.4%	$385
736	Pers. supply services	$82,469,891	$71,832,848	3.3%	$2,343,402	0.11%	3.5%	$2,207
737	Comptr & data proc. services	$38,985,907	$181,997,360	4.9%	$8,989,509	0.02%	0.4%	$438
738	Misc. business services	$33,639,921	$71,061,254	5.1%	$3,604,501	0.05%	0.9%	$393
751	Auto rentals, no drivers	$6,545,414	$28,628,943	5.4%	$1,559,917	0.02%	0.4%	$615
752	Automobile parking	$1,773,084	$4,810,800	4.4%	$211,333	0.04%	0.8%	$199
753	Automotive repair shops	$28,177,625	$52,456,660	3.9%	$2,024,838	0.05%	1.4%	$202
754	Automotive serv., exc repair	$10,203,088	$9,160,104	4.4% [d]	$406,480	0.11%	2.5%	$379
762	Electrical repair shops	$7,288,133	$12,355,727	4.6%	$572,812	0.06%	1.3%	$377
763	Watch and jewelry repair	$306,837	$374,160	5.4%	$20,339	0.08%	1.5%	$170
764	Reupholstery & furn. repair	$1,037,044	$1,276,653	5.4%	$69,396	0.08%	1.5%	$152
769	Misc. repair shops	$14,448,201	$24,393,605	5.9% [d]	$1,428,768	0.06%	1.0%	$370
781	Motion picture production	$14,989,448	$28,310,206	4.7% [d]	$1,333,418	0.05%	1.1%	$1,021
782	Motion picture dist.	$1,283,513	$18,051,508	5.1%	$927,457	0.01%	0.1%	$882
783	Motion picture theaters	$5,582,973	$7,023,730	6.3%	$439,512	0.08%	1.3%	$850
784	Video tape rental	$6,219,007	$6,459,177	5.9% [d]	$379,477	0.10%	1.6%	$299
791	Dance studios & schools	$446,492	$863,722	4.3%	$36,968	0.05%	1.2%	$78
792	Prducrs, orch., entertainers	$5,581,198	$16,444,890	4.6%	$758,789	0.03%	0.7%	$331
793	Bowling centers	$1,824,594	$2,944,692	3.8% [d]	$110,426	0.06%	1.7%	$318
794	Commercial sports	$4,986,471	$12,089,744	3.5%	$417,096	0.04%	1.2%	$1,047
799	Misc. recreation services	$42,280,573	$55,776,035	4.4%	$2,480,533	0.08%	1.7%	$684
801	Offices of medical doctors	$71,151,405	$186,598,097	6.4%	$11,895,629	0.04%	0.6%	$381
802	Dentists offices and clinics	$22,130,890	$46,131,244	10.5%	$4,820,715	0.05%	0.5%	$196
803	Osteopathic physicians	$1,253,148	$4,582,835	13.4% [e]	$612,954	0.03%	0.2%	$138
804	Other health practitioners	$17,910,457	$25,053,745	7.4%	$1,848,469	0.07%	1.0%	$212
805	Nursing & personal care fac.	$95,189,760	$63,625,522	4.7%	$3,014,592	0.15%	3.2%	$3,965

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						For All Establishments		
SIC	Industry	Annualized Compliance Costs for all Establishments	Revenues for all Establishments ($1,000s)	Profits as a Percentage of Revenues	Profits ($1,000s)	Annualized Compliance Costs as a Percentage of Revenues	Annualized Compliance Costs as a Percentage of Profits	Annualized Compliance Cost per Establishment
806	Hospitals	$264,170,417	$343,314,509	5.5%	$18,867,797	0.08%	1.4%	$36,277
807	Med. & dental labs	$8,668,894	$16,543,625	7.2%	$1,188,033	0.05%	0.7%	$569
808	Home hlth care services	$42,739,074	$27,690,537	3.2%	$879,175	0.15%	4.9%	$2,654
809	Hlth & allied serv., n.e.c.	$17,904,141	$26,036,633	6.7%	$1,745,383	0.07%	1.0%	$859
811	Legal services	$30,835,042	$116,202,122	17.5%	$20,335,371	0.03%	0.2%	$183
821	Elem. & secondary schools	$20,300,210	$30,967,943	5.9% [e]	$1,819,367	0.07%	1.1%	$1,127
822	Colleges & universities	$47,667,382	$73,194,239	9.1%	$6,688,549	0.07%	0.7%	$13,013
823	Libraries	$538,525	$846,367	8.1%	$68,908	0.06%	0.8%	$239
824	Vocational schools	$1,930,703	$6,322,931	6.3%	$399,121	0.03%	0.5%	$283
829	Schools, n.e.c.	$3,098,213	$7,437,108	5.5% [d]	$405,322	0.04%	0.8%	$201
832	Individual & fam. services	$24,059,183	$25,266,265	4.5%	$1,130,665	0.10%	2.1%	$559
833	Job train. & related serv.	$10,545,092	$8,830,464	3.4%	$300,236	0.12%	3.5%	$1,157
835	Child day care services	$12,397,073	$12,459,047	4.7%	$579,346	0.10%	2.1%	$231
836	Residential care	$26,267,710	$20,174,955	3.4%	$690,992	0.13%	3.8%	$913
839	Social services, n.e.c.	$6,954,902	$22,170,593	5.3%	$1,175,041	0.03%	0.6%	$443
841	Museums & art galleries	$2,088,113	$3,660,267	21.5%	$785,127	0.06%	0.3%	$462
842	Bot. & zoolog. gardens	$673,379	$906,476	21.5%	$194,439	0.07%	0.3%	$1,151
861	Business associations	$3,324,182	$14,242,520	3.9%	$560,206	0.02%	0.6%	$211
862	Prof. organizations	$1,562,948	$7,845,620	4.9% [d]	$384,435	0.02%	0.4%	$222
863	Labor organizations	$3,256,892	$11,731,332	8.6%	$1,008,895	0.03%	0.3%	$167
864	Civic & social assoc.	$11,815,935	$15,241,892	4.3%	$647,780	0.08%	1.8%	$320
865	Political organizations	$440,520	$1,093,341	7.2%	$78,846	0.04%	0.6%	$171
866	Religious organizations	$28,013,389	$57,709,235	8.9%	$5,121,695	0.05%	0.5%	$177
869	Membership orgs., n.e.c.	$4,202,676	$8,262,479	8.5% [d]	$702,311	0.05%	0.6%	$463
871	Eng. and arch. services	$32,230,001	$98,926,133	4.6%	$4,565,342	0.03%	0.7%	$409
872	Accntng, auditng, & bkeeping	$24,929,076	$49,834,103	12.0%	$5,955,175	0.05%	0.4%	$296
873	Research & testing services	$20,808,622	$47,185,349	4.9%	$2,321,878	0.04%	0.9%	$1,069
874	Management & pub. relations	$39,875,732	$96,714,846	6.3%	$6,051,135	0.04%	0.7%	$420
899	Services, n.e.c.	$5,945,705	$13,388,980	6.8%	$910,451	0.04%	0.7%	$345
	Subtotal	$3,979,807,204	$15,852,563,369		$788,983,644			
	Average (weighted)	$40,446,172	$110,726,844	5.6%	$5,229,943	0.05%	1.1%	$671
900	State and local governments	$558,536,987	$816,963,289	na	na	0.07%	na	$5,943
	Total	$4,538,344,191	$16,669,526,658		$788,983,644			

Source: Office of Regulatory Analysis.
Revenue data are from U.S. Dept. of Commerce, Bureau of Census. Compliance costs are from Chapter V of this Final Economic Analysis. Profit data are derived from Robert Morris Associates, RMA Annual Statement Studies 1995-1998 (RMA) and U.S. Department of the Treasury, 1995-1997 (IRS). Average profit rates for the period 1995 through 1998 were calculated from a weighted average of profit rates over this period for all 4-digit industries associated with each 3-digit SIC classification. Revenues were used as weights in this calculation.

*Total revenues from SIC 423 are supressed by the Census Bureau.
[a] Excludes SIC 3731.
[b] Profit rates, except where noted, are derived from Robert Morris Associates ' "RMA Studies."
[c] Profit data not available for all 4-digit industries in this classification; profit rates interpolated from a combination of RMA and IRS profit data.
[d] Based on a combination of RMA and IRS profit data.
[e] Based on IRS profit data.

G. Economic Impacts

To identify possible economic impacts, OSHA compared annualized costs to revenues and profits for all covered establishments, for small entities defined as small using Small Business Administration (SBA) size criteria, and for all small entities with 1–19 employees (Ex. 28–3). Costs were annualized over ten years, including the costs of controlling all of the MSDs projected to occur in the facility over that time period.

OSHA analyzed the impacts of the final standard's annualized compliance costs on small entities in each 3-digit SIC industry. The results of this analysis are shown in Tables VIII–4 and VIII–5. OSHA's procedures call for the agency to conduct a Final Regulatory Flexibility Analysis if, in any affected sector, the impact of the annualized compliance costs exceeds 1 percent of revenues or 5 percent of profits for a substantial number of small entities. As Table VIII–4 shows, in no 3-digit industry do the expected costs of compliance exceed 1 percent of revenues. However, the impact of the compliance costs exceeds 5 percent of profits for 1 industry, SIC 315, leather gloves and mittens.

Focusing on very small establishments, Table VIII–5 shows that no 3-digit industry has estimated costs that exceed one percent of average revenues. The table also shows that in no industry do impacts on profits exceed 5 percent.

However, OSHA analysis in Chapter VII of the Final Economic Analysis shows that some small entities and very small entities in the most affected class, those finding MSD hazards, would have compliance costs exceeding 5 percent of profits.

OSHA prepared an Initial Regulatory Flexibility Analysis as a follow up to convening a Small Business Regulatory Enforcement Fairness Act (SBREFA) Panel (the report of the Panel is in the docket of this rulemaking as Ex. 23). Based on the finding that in some industries the most affected small entities would have compliance costs exceeding 5 percent of profits, OSHA prepared a Final Regulatory Flexibility Analysis, a summary of which is presented in the next section.

Table VIII-4 Estimated Economic Impact Under Worst-Case Scenarios, of the Ergonomics Program Standard on Firms Meeting SBA Size Criteria

SIC	Industry	SBA size (Number of Employees)*	Annualized Compliance Costs for SBA Establishments	Revenues for SBA Firms ($1,000s)	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [c]	Profits for SBA Firms ($1,000s)	Average Profit per Firm (SBA) ($)	For all small firms: Average Cost per Firm (SBA) ($)	For all small firms: Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	For all small firms: Annualized Compliance Costs as a Percentage of Profits--SBA (percent)
074	Veterinary services	100	$6,497,378	$7,309,664	$323,809	6.1%	$448,648	$19,875	$286	0.09%	1.4%
075	Animal serv., excpt vet.	100	$909,475	$1,345,447	$130,385	6.0% [d]	$80,976	$7,847	$88	0.07%	1.1%
078	Lndscape & hort. services	500	$13,575,734	$15,120,877	$224,169	5.9%	$886,244	$13,139	$199	0.09%	1.5%
081	Timber tracts	100	$162,811	$402,898	$655,119	10.3% [d]	$41,498	$67,477	$192	0.03%	0.3%
083	Forest products	1000	$68,842	$247,111	$2,399,136	10.3% [d]	$25,452	$247,111	$690	0.03%	0.3%
085	Forestry services	500	$439,295	$742,159	$651,017	10.3% [d]	$76,442	$67,055	$285	0.04%	0.4%
091	Commercial fishing	100	$187,907	$684,364	$467,143	5.7% [d]	$39,303	$26,828	$97	0.02%	0.4%
092	Fish hatcheries	100	$25,248	$17,947	$263,926	6.1% [d]	$1,101	$16,191	$294	0.11%	1.8%
097	Hunting & trapping	100	$52,814	$55,959	$221,182	6.1% [d]	$3,433	$13,569	$160	0.07%	1.2%
131	Crude petrol. & nat. gas	500	$2,225,613	$27,927,970	$3,965,915	8.7%	$2,415,769	$343,052	$302	0.01%	0.1%
132	Natural gas liquids	500	$145,718	$2,888,360	$48,139,333	8.7% [d]	$249,843	$4,164,052	$339	0.00%	0.0%
138	Oil & gas field services	500	$3,052,903	$4,998,908	$626,980	8.7%	$432,406	$54,234	$362	0.06%	0.7%
201	Meat products	500	$2,483,498	$21,871,360	$8,956,331	2.6%	$558,467	$228,692	$915	0.01%	0.4%
202	Dairy products	500	$3,358,216	$19,094,397	$15,094,385	3.4%	$656,303	$518,817	$1,918	0.01%	0.4%
203	Presrvd fruits & vegetables	500	$2,057,534	$13,298,874	$9,121,313	4.0%	$530,163	$363,623	$1,117	0.01%	0.3%
204	Grain mill products	500	$2,850,176	$15,246,146	$9,680,093	3.3%	$503,441	$319,645	$1,231	0.01%	0.4%
205	Bakery products	500	$3,671,005	$6,776,815	$2,270,290	3.7%	$248,907	$83,386	$1,080	0.05%	1.3%
206	Sugar and confect. prods	500	$1,507,294	$5,665,724	$6,274,334	3.6%	$205,900	$228,017	$1,456	0.02%	0.6%
207	Fats and oils	500	$857,689	$4,164,853	$17,798,517	3.5% [d]	$144,248	$616,445	$1,916	0.01%	0.3%
208	Beverages	500	$3,427,274	$18,683,495	$10,514,066	4.7% [e]	$885,475	$498,298	$1,573	0.01%	0.3%
209	Misc. food products	500	$3,924,958	$15,725,677	$4,590,098	3.1% [e]	$492,202	$143,667	$1,032	0.02%	0.7%
211	Cigarettes	1000	$552,493	$25,695,548	$2,569,554,800	4.0% [d]	$1,032,237	$103,223,683	$55,249	0.00%	0.1%
212	Cigars	500	$53,913	$76,374	$1,909,350	4.0% [d]	$3,068	$76,702	$1,172	0.06%	1.5%
213	Chewing & smoking tobacco	500	$90,246	$391,541	$21,752,278	4.0% [d]	$15,729	$873,829	$3,471	0.02%	0.4%
214	Tobacco stemm. & redrying	500	$94,976	$537,268	$29,848,222	4.0% [d]	$21,583	$1,199,057	$3,275	0.01%	0.3%
221	Brdwven fab. mills, cotton	1000	$1,041,062	$6,018,357	$15,713,726	4.0%	$237,725	$620,692	$2,850	0.02%	0.5%
222	Broadwoven fabric mills	500	$825,069	$1,615,840	$5,404,147	2.8% [e]	$44,729	$149,594	$2,028	0.04%	1.4%
223	Brdwvn fab. mills, wool	500	$86,335	$462,121	$5,776,513	2.8% [e]	$12,792	$159,901	$1,007	0.02%	0.6%
224	Narrow fabric mills	500	$479,645	$800,096	$3,448,690	3.2%	$25,403	$109,496	$1,849	0.05%	1.7%
225	Knitting mills	500	$2,199,261	$6,047,280	$3,597,430	2.9%	$173,600	$103,272	$1,214	0.03%	1.2%
226	Tex. finishing, excpt wool	500	$912,515	$3,223,076	$4,235,317	2.8%	$90,367	$118,748	$1,110	0.03%	0.9%
227	Carpets and rugs	500	$473,767	$2,065,927	$5,177,762	2.8%	$57,329	$143,683	$1,082	0.02%	0.8%
228	Yarn and thread mills	500	$1,541,008	$2,447,819	$8,354,331	2.0%	$48,127	$164,256	$2,926	0.04%	1.8%
229	Misc. textile goods	500	$1,294,370	$3,747,540	$4,445,480	2.8% [e]	$105,565	$125,225	$1,358	0.03%	1.1%
231	Men's & boys' suits & coats	500	$285,711	$705,937	$2,881,376	0.9% [e]	$6,530	$26,653	$1,070	0.04%	4.0%
232	Men's & boys' furnishings	500	$2,769,842	$5,102,159	$3,171,012	2.7%	$138,566	$86,120	$1,446	0.05%	1.7%
233	Wm's & misses' outerwear	500	$3,544,053	$14,309,804	$1,569,746	2.6%	$369,119	$40,491	$401	0.03%	1.0%
234	Wm's & chldrn's undergarmnts	500	$410,244	$1,109,998	$3,775,503	2.4% [e]	$26,800	$91,158	$1,233	0.03%	1.4%
235	Hats, caps, & millinery	500	$255,378	$615,079	$1,649,005	3.9%	$24,142	$64,723	$694	0.04%	1.1%
236	Girls' & chldrn's outerwear	500	$407,657	$1,382,929	$2,669,747	2.0%	$27,306	$52,713	$733	0.03%	1.4%
237	Fur goods	500	$23,958	$142,828	$1,027,540	2.6%	$3,654	$26,286	$180	0.02%	0.7%
238	Misc. apparel & accessories	500	$538,584	$1,480,734	$1,580,292	2.6% [e]	$38,050	$40,608	$591	0.04%	1.5%
239	Misc. fab. textile prods	500	$3,534,665	$11,758,209	$1,304,873	2.6%	$306,884	$34,057	$409	0.03%	1.2%
241	Logging	500	$1,931,225	$13,244,206	$929,614	3.9% [f]	$516,390	$36,246	$136	0.01%	0.4%
242	Sawmills & planing mills	500	$5,204,162	$15,942,346	$2,910,249	4.3%	$684,700	$124,991	$887	0.03%	0.7%
243	Millwork & plywood	500	$7,638,094	$16,491,731	$1,826,529	3.6%	$594,072	$65,796	$814	0.04%	1.2%
244	Wood containers	500	$1,826,524	$3,748,376	$1,369,020	3.7%	$137,252	$50,129	$666	0.05%	1.3%
245	Wood bldings & mobile homes	500	$2,492,973	$3,871,282	$4,950,488	3.8%	$145,465	$186,017	$2,519	0.05%	1.4%
249	Misc. wood products	500	$2,644,679	$6,955,302	$2,178,297	3.9% [e]	$269,561	$84,423	$776	0.04%	0.9%
251	Household furniture	500	$4,830,833	$10,807,198	$2,073,124	3.2%	$345,797	$66,334	$911	0.04%	1.4%

Table VIII-4 Estimated Economic Impact Under Worst-Case Scenarios, of the Ergonomics Program Standard on Firms Meeting SBA Size Criteria

SIC	Industry	SBA size (Number of Employees)*	Annualized Compliance Costs for SBA Establishments	Revenues for SBA Firms ($1,000s)	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [c]	Profits for SBA Firms ($1,000s)	Average Profit per Firm (SBA) ($)	For all small firms: Average Cost per Firm (SBA) ($)	For all small firms: Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	For all small firms: Annualized Compliance Costs as a Percentage of Profits--SBA (percent)
252	Office furniture	500	$1,291,889	$2,732,201	$3,012,350	3.8%	$104,776	$115,519	$1,309	0.04%	1.1%
253	Pub blding & related furn.	500	$1,008,885	$2,252,316	$5,819,938	4.1%	$91,782	$237,162	$2,344	0.04%	1.0%
254	Partitions and fixtures	500	$2,754,129	$6,322,138	$2,089,272	3.7%	$234,829	$77,604	$933	0.04%	1.2%
259	Misc furniture and fixtures	500	$1,042,016	$2,843,495	$2,117,271	3.2%	$89,618	$66,730	$754	0.04%	1.1%
261	Pulp mills	750	$451,825	$5,790,710	$134,667,674	4.5%	$260,635	$6,061,288	$10,508	0.01%	0.2%
262	Paper mills	750	$4,711,179	$35,582,333	$191,302,866	4.8% [e]	$1,690,161	$9,086,886	$25,329	0.01%	0.3%
263	Paperboard mills	750	$1,700,828	$19,869,962	$196,732,297	4.5% [d]	$894,332	$8,854,769	$16,840	0.01%	0.2%
265	Paperbrd containers & boxes	500	$6,614,525	$14,020,165	$8,670,479	4.6%	$640,780	$396,277	$2,598	0.03%	0.7%
267	Misc. cnvrtd paper products	500	$5,690,027	$15,570,727	$6,820,292	4.3%	$670,269	$293,591	$2,021	0.03%	0.7%
271	Newspapers	500	$6,097,033	$7,829,630	$1,125,756	3.8% [d]	$297,489	$42,773	$750	0.07%	1.8%
272	Periodicals	500	$1,858,408	$11,989,180	$2,200,657	3.8%	$455,589	$83,625	$327	0.01%	0.4%
273	Books	500	$1,881,460	$8,172,158	$2,457,053	4.5% [e]	$366,256	$110,119	$543	0.02%	0.5%
274	Miscellaneous publishing	500	$1,271,575	$5,302,578	$1,795,050	4.5%	$237,290	$80,328	$401	0.02%	0.5%
275	Commercial printing	500	$15,843,451	$44,739,282	$1,315,823	3.4%	$1,540,599	$45,310	$468	0.04%	1.0%
276	Manifold business forms	500	$1,504,029	$3,614,775	$5,561,192	3.4%	$121,095	$186,300	$1,903	0.03%	1.0%
277	Greeting cards	500	$199,647	$856,946	$6,967,041	3.8% [d]	$32,560	$264,715	$1,490	0.02%	0.6%
278	Blankbooks & bookbinding	500	$1,558,022	$2,534,882	$1,749,401	3.9%	$99,828	$68,894	$1,006	0.06%	1.5%
279	Printing trade services	500	$1,521,084	$3,736,702	$1,124,497	3.6% [e]	$133,797	$40,264	$451	0.04%	1.1%
281	Indust. inorganic chemicals	1000	$2,210,991	$30,002,480	$50,087,613	4.5% [e]	$1,348,616	$2,251,445	$3,707	0.01%	0.2%
282	Plastics mat. & synthetics	750	$2,930,842	$57,333,971	$100,234,215	4.5%	$2,577,543	$4,506,194	$5,200	0.01%	0.1%
283	Drugs	500	$2,026,527	$14,377,569	$11,576,143	4.8%	$688,184	$554,093	$1,362	0.01%	0.2%
284	Soap, clnrs, & toilet goods	500	$1,937,045	$13,947,232	$6,619,474	4.4%	$613,851	$291,339	$835	0.01%	0.3%
285	Paints & allied products	500	$1,130,554	$6,934,916	$6,147,975	3.8%	$260,059	$230,549	$821	0.01%	0.4%
286	Indust. organic chemicals	500	$1,790,244	$8,875,050	$18,842,994	4.5%	$398,267	$845,578	$2,248	0.01%	0.3%
287	Agricultural chemicals	500	$652,941	$5,064,778	$7,976,028	3.8%	$191,034	$300,840	$761	0.01%	0.3%
289	Misc. chemical products	500	$1,972,137	$11,248,653	$6,784,471	4.8% [e]	$535,062	$322,715	$868	0.01%	0.3%
291	Petroleum refining	1500	$2,633,929	$145,808,878	$837,982,057	2.9%	$4,155,553	$23,882,489	$15,193	0.00%	0.1%
295	Asphlt pavng & roofng mat.	500	$1,078,661	$4,484,234	$7,498,719	3.9%	$175,673	$293,768	$1,077	0.01%	0.4%
299	Misc. pet. & coal prods	500	$389,654	$3,602,880	$11,017,982	4.7%	$170,723	$522,088	$926	0.01%	0.2%
301	Tires and inner tubes	1000	$2,023,808	$12,649,425	$110,959,868	4.0% [d]	$509,114	$4,465,916	$17,753	0.02%	0.4%
302	Rubber & plastics footwear	1000	$196,589	$688,879	$14,058,755	4.0% [d]	$27,726	$565,837	$4,078	0.03%	0.7%
305	Hose, bltng, and gaskets	500	$1,017,513	$2,376,018	$3,876,049	4.0%	$94,966	$154,919	$1,340	0.03%	0.9%
306	Fab. rubber prod., n.e.c.	500	$2,189,498	$5,779,201	$4,274,557	4.0%	$232,601	$172,042	$1,352	0.03%	0.8%
308	Misc plastics, n.e.c.	500	$15,360,776	$50,183,465	$4,687,853	4.0%	$2,020,849	$188,776	$1,210	0.03%	0.6%
311	Leather tan. & finishing	500	$414,762	$964,049	$3,171,214	1.7%	$16,630	$54,703	$1,244	0.04%	2.3%
313	Footwear cut stock	500	$69,963	na	na [b]	2.2% [d]	na	na	$1,030	na	na
314	Footwear, except rubber	500	$712,528	$998,863	$3,351,889	2.3%	$23,410	$78,557	$1,995	0.06%	2.5%
315	Leather gloves & mittens	500	$104,912	$65,592	$1,261,385 [b]	2.2% [d]	$1,441	$27,710	$1,842	0.15%	6.6%
316	Luggage	500	$188,039	$650,092	$2,600,368	2.9%	$19,015	$76,061	$738	0.03%	1.0%
317	Hndbags & prsnal leathr gds.	500	$156,358	$521,156	$1,514,988 [b]	2.2% [d]	$11,449	$33,281	$465	0.03%	1.4%
319	Leather goods, n.e.c.	500	$252,722	$555,521	$1,368,278	2.2% [f]	$12,203	$30,058	$628	0.05%	2.1%
321	Flat glass	1000	$524,469	$2,709,081	$44,411,164	4.9% [d]	$133,468	$2,187,995	$8,704	0.02%	0.4%
322	Glass, pressed or blown	750	$2,308,237	$9,244,687	$18,905,290	4.9% [f]	$455,456	$931,403	$4,720	0.02%	0.5%
323	Prod. of purchased glass	500	$1,423,171	$2,883,972	$1,988,946	5.1%	$145,641	$100,442	$890	0.04%	0.9%
324	Cement, hydraulic	750	$727,441	$4,720,190	$32,779,097	4.9% [d]	$232,549	$1,614,921	$5,117	0.02%	0.3%
325	Structural clay products	500	$1,151,767	$1,261,365	$3,234,269	5.4%	$67,909	$174,125	$2,130	0.07%	1.2%
326	Pottery & related prods	500	$900,355	$1,218,562	$1,082,204	4.9% [d]	$60,035	$53,317	$767	0.07%	1.4%
327	Concrete & plast. prdcts	500	$8,138,716	$19,732,738	$3,222,724	4.8%	$952,760	$155,603	$1,080	0.03%	0.7%
328	Cut stone & stone prods	500	$535,838	$1,016,183	$965,036	5.0%	$51,063	$48,493	$507	0.05%	1.0%
329	Misc. nonmet. mineral prods.	500	$1,686,396	$4,522,903	$3,852,558	5.0% [e]	$223,990	$190,792	$1,143	0.03%	0.6%

Table VIII-4 Estimated Economic Impact Under Worst-Case Scenarios, of the Ergonomics Program Standard on Firms Meeting SBA Size Criteria

									For all small firms		
SIC	Industry	SBA size (Number of Employees)*	Annualized Compliance Costs for SBA Establishments	Revenues for SBA Firms ($1,000s)	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [c]	Profits for SBA Firms ($1,000s)	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	Annualized Compliance Costs as a Percentage of Profits--SBA (percent)
331	Basic steel products	750	$6,902,635	$69,010,676	$71,587,838	4.3%	$2,971,554	$3,082,524	$7,199	0.01%	0.2%
332	Iron and steel foundries	500	$2,188,182	$4,870,320	$5,316,943	4.6%	$221,896	$242,244	$2,064	0.04%	0.9%
333	Primary nonfer. metals	750	$1,072,534	$17,465,720	$104,585,150	4.5% [d]	$789,048	$4,724,837	$6,422	0.01%	0.1%
334	Secondary nonfer. metals	500	$480,535	$4,175,342	$19,152,945	3.9%	$161,795	$742,177	$1,768	0.01%	0.2%
335	Nonfer. rolling & drawing	750	$4,642,135	$45,476,554	$58,983,857	4.9%	$2,211,228	$2,868,000	$6,070	0.01%	0.2%
336	Nonfer. foundries (cstngs)	500	$2,106,085	$5,180,943	$3,491,201	4.5%	$232,907	$156,945	$1,313	0.04%	0.8%
339	Misc. primary metal prdcts	750	$850,154	$4,169,927	$5,066,740	4.8%	$201,967	$245,403	$1,036	0.02%	0.4%
341	Met. cans & ship. containers	500	$1,340,069	$1,621,160	$8,487,749	4.1%	$65,707	$344,014	$3,363	0.04%	1.0%
342	Cutlery, hndtls, & hardware	500	$2,591,818	$6,691,129	$3,168,148	4.6% [e]	$308,517	$146,078	$1,120	0.04%	0.8%
343	Plumbing & heating fixtures	500	$1,115,960	$3,157,332	$5,500,578	4.8%	$150,644	$262,446	$1,701	0.03%	0.6%
344	Fab. struct. metal prdcts	500	$12,175,304	$37,977,730	$3,142,031	4.3%	$1,626,612	$134,575	$942	0.03%	0.7%
345	Screw machine products	500	$3,124,799	$8,090,741	$3,399,471	4.4%	$357,767	$150,322	$1,245	0.04%	0.8%
346	Met. forgings & stampings	500	$5,798,684	$18,722,856	$5,900,679	4.6%	$854,915	$269,434	$1,660	0.03%	0.6%
347	Metal services, n.e.c.	500	$4,180,962	$9,995,919	$1,930,459	5.0%	$494,858	$95,569	$782	0.04%	0.8%
348	Ordnance and access., n.e.c.	500	$384,830	$733,846	$1,916,047	4.5% [d]	$33,362	$87,106	$932	0.05%	1.1%
349	Misc. fab. metal products	500	$7,451,850	$20,152,405	$3,139,004	4.9%	$986,213	$153,616	$1,062	0.03%	0.7%
351	Engines and turbines	1000	$2,290,030	$16,985,636	$56,430,684	4.0% [d]	$687,199	$2,283,054	$7,629	0.01%	0.3%
352	Farm & garden machinery	500	$1,583,707	$4,821,398	$3,024,716	4.7%	$227,886	$142,965	$940	0.03%	0.7%
353	Construct. & related mach.	500	$3,643,013	$12,575,744	$4,366,578	4.3%	$543,864	$188,842	$1,148	0.03%	0.6%
354	Metalworking machinery	500	$7,880,566	$21,483,547	$1,923,153	4.6%	$986,237	$88,286	$680	0.04%	0.8%
355	Special industry mach.	500	$4,186,825	$15,982,001	$3,696,115	4.1%	$648,701	$150,023	$904	0.02%	0.6%
356	General indust. mach.	500	$5,661,332	$15,116,697	$4,271,460	4.3%	$656,138	$185,402	$1,362	0.03%	0.7%
357	Computer & office equip.	500	$1,791,829	$12,243,311	$6,625,168	3.3%	$403,103	$218,129	$899	0.01%	0.4%
358	Refrig. & serv. indust mach.	500	$2,854,849	$8,739,705	$4,721,613	3.6%	$314,109	$169,697	$1,346	0.03%	0.8%
359	Industrial mach., n.e.c.	500	$11,136,527	$27,692,881	$1,086,294	5.1% [e]	$1,400,654	$54,943	$434	0.04%	0.8%
361	Elect. dist. equipment	750	$1,615,579	$11,273,986	$14,873,332	5.2%	$583,158	$769,337	$2,158	0.01%	0.3%
362	Elect. indust. apparatus	500	$2,461,026	$6,300,493	$3,392,834	5.1%	$323,830	$174,383	$1,144	0.03%	0.7%
363	Household appliances	500	$645,445	$1,916,838	$5,756,270	5.6% [d]	$107,177	$321,852	$1,568	0.03%	0.5%
364	Elct. lghtng & wire equip.	500	$2,335,322	$7,587,353	$4,355,541	5.7%	$434,863	$249,634	$1,162	0.03%	0.5%
365	Household audio & vid. equip.	750	$1,121,446	$13,716,113	$17,721,076	5.0%	$689,969	$891,433	$1,460	0.01%	0.2%
366	Communications equipment	750	$4,824,912	$57,675,808	$30,039,483	5.8% [e]	$3,319,137	$1,728,717	$2,532	0.01%	0.1%
367	Electrnic compnnts & access.	500	$5,499,452	$23,959,350	$4,279,984	5.6%	$1,336,749	$238,790	$889	0.02%	0.4%
369	Misc. elect. equipment	500	$2,024,078	$6,460,095	$4,403,609	5.9% [e]	$380,534	$259,396	$1,213	0.03%	0.5%
371	Motor vehicles & equipt.	500	$8,943,314	$22,926,322	$5,821,819	3.5%	$802,758	$203,849	$1,931	0.03%	0.9%
372	Aircraft and parts	1000	$10,748,768	$93,016,989	$64,238,252	4.7% [e]	$4,339,753	$2,997,067	$7,436	0.01%	0.2%
373	Ship, boat blding and repair [a]	500	$2,267,952	$3,523,310	$1,358,254	3.6%	$128,325	$49,470	$859	0.06%	1.7%
374	Railroad equipment	1000	$869,095	$6,654,526	$43,779,776	3.7%	$244,554	$1,608,907	$5,771	0.01%	0.4%
375	Motorcycles & bicycles	500	$223,223	$883,486	$2,531,479	3.7%	$33,070	$94,756	$615	0.02%	0.6%
376	Guided missiles	1000	$1,721,893	$18,052,173	$231,438,115	3.7%	$675,714	$8,663,001	$22,286	0.01%	0.3%
379	Misc. transportation equip.	500	$835,625	$3,155,211	$3,063,312	3.7% [e]	$115,388	$112,027	$761	0.02%	0.7%
381	Srch & navigation equipment	750	$3,473,317	$30,132,161	$51,158,168	4.7% [e]	$1,416,212	$2,404,434	$5,905	0.01%	0.2%
382	Meas. & contrlling devices	500	$3,484,911	$14,397,362	$3,508,984	5.6%	$808,467	$197,043	$763	0.02%	0.4%
384	Medical instrmnts & supplies	500	$3,097,673	$14,243,807	$3,717,069	5.3% [e]	$756,732	$197,477	$730	0.02%	0.4%
385	Ophthalmic goods	500	$289,433	$775,726	$1,524,020	3.7%	$28,508	$56,008	$511	0.03%	0.9%
386	Photo. equip. & supplies	500	$484,318	$2,498,427	$3,934,531	4.0%	$99,937	$157,381	$693	0.02%	0.4%
387	Watches, clocks, & parts	500	$56,467	$282,180	$2,121,654	5.1% [d]	$14,281	$107,376	$409	0.02%	0.4%
391	Jwlry, slvrwre, and plate	500	$718,697	$4,852,914	$1,704,571	3.3%	$161,574	$56,752	$257	0.02%	0.5%
393	Musical instruments	500	$319,673	$766,619	$1,432,933	3.8% [d]	$29,164	$54,512	$586	0.04%	1.1%
394	Toys and sporting goods	500	$1,760,361	$7,306,766	$2,141,491	3.7%	$267,402	$78,371	$512	0.02%	0.7%
395	Office and art supplies	500	$447,103	$1,893,745	$1,910,943	3.8% [d]	$72,042	$72,697	$448	0.02%	0.6%

Table VIII-4 Estimated Economic Impact Under Worst-Case Scenarios, of the Ergonomics Program Standard on Firms Meeting SBA Size Criteria

									For all small firms		
SIC	Industry	SBA size (Number of Employees)*	Annualized Compliance Costs for SBA Establishments	Revenues for SBA Firms ($1,000s)	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [c]	Profits for SBA Firms ($1,000s)	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	Annualized Compliance Costs as a Percentage of Profits--SBA (percent)
396	Costume jewelry & notions	500	$299,582	$1,300,768	$1,192,271	3.8% [d]	$49,484	$45,357	$278	0.02%	0.6%
399	Misc. manufactures	500	$3,324,791	$12,545,710	$1,443,695	4.1%	$510,610	$58,758	$383	0.03%	0.7%
411	Local & suburban trans.	500	$8,173,462	$5,876,806	$693,674	4.4%	$258,515	$30,514	$916	0.13%	3.0%
412	Taxicabs	500	$634,660	$1,105,735	$334,160	4.5% [d]	$49,844	$15,063	$193	0.06%	1.3%
413	Intercty & rural bus trans.	500	$467,639	$585,677	$2,047,822	5.4%	$31,480	$110,070	$1,213	0.06%	1.1%
414	Bus charter service	500	$1,139,408	$1,457,057	$1,112,257	4.6%	$66,962	$51,116	$853	0.08%	1.7%
415	School buses	500	$3,945,981	$2,135,801	$655,154	4.6%	$97,179	$29,809	$982	0.15%	3.3%
417	Bus terminals	100	$22,362	$9,269	$178,250	4.5% [d]	$418	$8,035	$399	0.22%	5.0%
421	Trking & Courier Service	100	$37,789,609	$70,008,631	$682,252	3.4%	$2,407,318	$23,460	$334	0.05%	1.4%
422	Pub. warehousing & storage	1000	$8,804,368	$5,737,546	$645,103	10.7%	$611,567	$68,762	$1,003	0.16%	1.5%
423	Trucking terminal fac.	500	$69,378	$38,086	$528,972 [b]	3.9% [d]	$1,491	$20,703	$867	0.16%	4.2%
430	U.S. Postal Service	na	na	na	na	na	na	na	na	na	na
451	Air trans., scheduled	1500	$24,340,198	$139,896,879	$84,888,883	3.6% x	$4,977,185	$3,020,136	$14,848	0.02%	0.5%
452	Air trans., nonsched.	1500	$780,090	$4,596,451	$2,785,728	5.3%	$243,612	$147,644	$479	0.02%	0.3%
458	Airports and services	100	$1,553,070	$2,548,936	$815,921	3.8%	$97,497	$31,209	$416	0.05%	1.3%
461	Pipelines, excpt natural gas	1500	$1,033,860	$8,949,097	$88,604,921	6.5% [d]	$585,965	$5,801,632	$10,289	0.01%	0.2%
472	Pass. trans. arrangements	100	$2,638,317	$7,842,150	$291,573	2.4%	$190,399	$7,079	$85	0.03%	1.2%
473	Freight trans. arrangements	1000	$6,786,441	$13,557,555	$1,127,447	3.9%	$521,966	$43,407	$577	0.05%	1.3%
474	Rental of railroad cars	20	$13,504	$227,179	$3,112,041	3.4% [d]	$7,704	$105,530	$136	0.00%	0.1%
478	Misc. trans. services	100	$1,727,132	$1,199,860	$597,838	5.4%	$64,961	$32,367	$695	0.12%	2.1%
481	Telephone communication	1500	$14,854,888	$208,432,617	$30,966,070	5.9%	$12,368,636	$1,837,563	$2,242	0.01%	0.1%
482	Telegrph & other comm.	100	$50,194	$639,961	$1,587,993	5.6% [f]	$35,704	$88,596	$114	0.01%	0.1%
483	Radio & TV broadcasting	100	$1,169,877	$5,760,487	$828,013	6.6%	$380,357	$54,673	$151	0.02%	0.3%
484	Cable & othr pay TV services	100	$975,082	$4,447,226	$2,309,048	2.7%	$121,187	$62,922	$245	0.01%	0.4%
489	Communication serv., n.e.c.	100	$102,117	$2,012,842	$1,476,773	6.1%	$122,783	$90,083	$72	0.00%	0.1%
491	Electric services	100	$1,984,774	$12,729,512	$10,459,747	12.5%	$1,586,946	$1,303,982	$483	0.00%	0.0%
492	Gas product. & distribution	10	$219,701	$2,605,588	$5,639,801	7.9%	$205,348	$444,476	$119	0.00%	0.0%
493	Comb. utility services	20	$106,180	$306,134	$1,749,337	10.4% [d]	$31,761	$181,489	$122	0.01%	0.1%
494	Water supply	100	$455,092	$1,422,434	$417,626	12.2%	$173,893	$51,055	$126	0.03%	0.2%
495	Sanitary services	100	$1,768,449	$5,967,715	$1,250,569	6.2%	$372,958	$78,156	$293	0.02%	0.4%
496	Steam & air-cond. supplies	100	$16,197	$50,218	$1,091,696	10.4% [d]	$5,210	$113,261	$258	0.02%	0.2%
497	Irrigation systems	100	$30,402	$71,818	$203,450	10.4% [d]	$7,451	$21,107	$84	0.04%	0.4%
501	Motor vehicles	100	$17,794,990	$243,498,263	$7,338,706	2.2%	$5,332,451	$160,713	$437	0.01%	0.3%
502	Furn. & homefurnishings	100	$6,371,889	$45,558,231	$3,107,868	2.3%	$1,040,619	$70,988	$406	0.01%	0.6%
503	Lumber & construct. mat.	100	$14,581,037	$71,149,013	$3,956,240	2.3%	$1,637,651	$91,062	$662	0.02%	0.7%
504	Prof. & commercial equip.	100	$16,865,174	$117,949,440	$2,865,424	2.7%	$3,220,156	$78,229	$347	0.01%	0.4%
505	Met. & minerals, excpt pet.	100	$6,104,097	$88,083,233	$10,345,693	2.6%	$2,275,420	$267,256	$577	0.01%	0.2%
506	Electrical goods	100	$13,183,348	$152,717,682	$5,334,184	2.5%	$3,829,564	$133,761	$349	0.01%	0.3%
507	Hardware supplies	100	$12,831,802	$59,471,522	$3,243,960	2.5%	$1,495,727	$81,587	$555	0.02%	0.7%
508	Mach., equipt, & supplies	100	$32,266,054	$185,868,942	$3,120,491	2.9%	$5,361,954	$90,020	$464	0.01%	0.5%
509	Misc. durable goods	100	$10,408,783	$114,520,585	$3,072,234	3.0% [e]	$3,404,665	$91,337	$269	0.01%	0.3%
511	Paper and paper products	100	$5,842,403	$54,840,021	$4,200,691	1.9%	$1,059,399	$81,149	$333	0.01%	0.4%
512	Drugs, propriet., & sundries	100	$2,858,374	$37,353,268	$6,828,751	3.6% [e]	$1,335,379	$244,128	$417	0.01%	0.2%
513	Apparel and notions	100	$5,356,497	$77,016,584	$3,898,982	2.5%	$1,908,792	$96,633	$254	0.01%	0.3%
514	Groceries & related products	100	$21,297,198	$218,814,846	$6,267,970	1.8%	$3,868,372	$110,810	$525	0.01%	0.5%
515	Farm-prod. raw materials	100	$2,399,331	$95,011,629	$13,088,804	28.3%	$26,913,704	$3,707,633	$268	0.00%	0.0%
516	Chemicals & allied prods	100	$5,212,117	$70,151,235	$6,688,714	3.1%	$2,163,096	$206,245	$369	0.01%	0.2%
517	Petrol. & petrol. prods	100	$4,993,945	$159,830,273	$18,899,169	1.3%	$2,039,195	$241,125	$436	0.00%	0.2%
518	Beer, wine, & dist. bev.	100	$4,589,822	$28,349,716	$7,805,539	3.5%	$996,809	$274,452	$1,048	0.01%	0.4%
519	Misc. nondurable goods	100	$13,263,715	$107,195,186	$2,420,357	2.3%	$2,476,936	$55,927	$259	0.01%	0.5%

Table VIII-4 Estimated Economic Impact Under Worst-Case Scenarios, of the Ergonomics Program Standard on Firms Meeting SBA Size Criteria

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521	Lumber & other blding mat.	100	$15,104,187	$34,646,566	$2,041,155	2.3%	$796,871	$46,947	$711	0.03%	1.5%
523	Paint, glass, wallpaper strs	100	$2,952,482	$4,198,092	$746,327	2.3%	$94,457	$16,792	$333	0.04%	2.0%
525	Hardware stores	100	$4,522,768	$9,295,593	$747,354	2.2%	$199,855	$16,068	$332	0.04%	2.1%
526	Retail nurseries and gardens	100	$3,926,459	$6,916,627	$685,629	2.5% [e]	$169,457	$16,798	$359	0.05%	2.1%
527	Mobile home dealers	100	$2,754,481	$9,308,186	$2,506,918	3.2%	$300,189	$80,848	$635	0.03%	0.8%
531	Department stores	500	$107,125,395	$14,920,000	$90,424,242	2.8%	$417,760	$2,531,879	$10,568	0.01%	0.4%
533	Variety stores	500	$5,246,950	$2,014,120	$518,168	3.1%	$62,438	$16,063	$546	0.11%	3.4%
539	Misc. gen. merchandise strs.	100	$4,662,095	$6,172,672	$867,314	2.2%	$135,799	$19,081	$349	0.04%	1.8%
541	Grocery stores	500	$88,221,377	$118,331,661	$1,354,669	1.4%	$1,597,477	$18,288	$761	0.06%	4.2%
542	Meat and fish markets	500	$1,668,617	$5,312,763	$698,037	2.5%	$132,819	$17,451	$220	0.03%	1.3%
543	Fruit & vegetable markets	500	$556,557	$2,156,122	$670,436	1.4% [d]	$30,418	$9,458	$173	0.03%	1.8%
544	Candy, nut, & confctnry strs	500	$804,252	$1,075,952	$356,630	4.1%	$43,845	$14,533	$203	0.06%	1.4%
545	Dairy products stores	500	$375,186	$555,577	$357,975	1.4% [d]	$7,838	$5,050	$155	0.04%	3.1%
546	Retail bakeries	500	$4,696,328	$5,263,348	$310,632	3.2%	$168,427	$9,940	$255	0.08%	2.6%
549	Misc. food stores	100	$1,497,845	$3,638,480	$485,584	2.4%	$86,414	$11,533	$157	0.03%	1.4%
551	New and used car dealers	100	$27,553,404	$292,038,764	$14,022,797	1.2% [e]	$3,577,475	$171,779	$1,240	0.01%	0.7%
552	Used car dealers	1000	$1,643,727	$26,046,018	$1,204,329	2.5%	$638,127	$29,506	$76	0.01%	0.3%
553	Auto & home supply stores	100	$16,983,595	$19,937,515	$734,699	2.3%	$453,578	$16,714	$419	0.06%	2.5%
554	Gas service stations	100	$20,398,832	$92,849,080	$1,661,818	1.6%	$1,485,585	$26,589	$245	0.01%	0.9%
555	Boat dealers	100	$1,855,789	$6,941,415	$1,497,285	2.0%	$135,358	$29,197	$378	0.03%	1.3%
556	Rec. vehicle dealers	20	$960,565	$3,776,117	$1,564,906	2.1%	$77,410	$32,081	$375	0.02%	1.2%
557	Motorcycle dealers	100	$400,981	$6,364,205	$1,722,849	2.8%	$178,198	$48,240	$108	0.01%	0.2%
559	Auto dealers, n.e.c.	500	$105,020	$1,290,175	$1,054,926	2.6% [e]	$33,545	$27,428	$86	0.01%	0.3%
561	Men's & boys' clothing strs	100	$1,735,648	$4,530,201	$734,468	1.4%	$62,290	$10,099	$142	0.02%	1.4%
562	Women's clothing stores	100	$5,068,226	$8,659,216	$521,388	1.1%	$95,251	$5,735	$139	0.03%	2.4%
563	Wm's access.& specialty strs	100	$912,098	$1,692,509	$424,294	1.8% [d]	$31,255	$7,835	$115	0.03%	1.5%
564	Chldrn's & infants' wear strs	100	$893,447	$1,349,923	$442,743	1.8% [d]	$24,929	$8,176	$181	0.04%	2.2%
565	Family clothing stores	100	$7,587,500	$5,923,495	$811,771	2.2%	$127,355	$17,453	$436	0.05%	2.5%
566	Shoe stores	100	$4,865,601	$5,381,323	$720,198	2.4%	$130,497	$17,465	$190	0.03%	1.1%
569	Misc. apparel stores	500	$820,287	$3,709,783	$486,401	2.0%	$74,196	$9,728	$90	0.02%	0.9%
571	Furnitre & homefurnishng strs	100	$23,391,313	$42,126,313	$837,185	2.4%	$1,030,187	$20,473	$385	0.05%	1.9%
572	Household appliance strs	100	$3,014,842	$7,560,615	$851,037	2.2%	$168,224	$18,936	$323	0.04%	1.7%
573	Radio, TV, & comptr strs	100	$8,489,629	$25,990,643	$1,073,328	2.1%	$550,911	$22,751	$233	0.02%	1.0%
581	Eating & drinking places	500	$139,237,475	$168,250,630	$469,053	3.0%	$5,044,847	$14,064	$325	0.07%	2.3%
591	Drug stores	100	$13,932,223	$30,098,137	$1,276,589	2.2%	$654,634	$27,766	$347	0.03%	1.3%
592	Liquor stores	1000	$1,667,710	$21,457,553	$803,413	1.6%	$337,956	$12,654	$68	0.01%	0.5%
593	Used merchandise stores	500	$4,154,670	$6,333,307	$327,184	4.8%	$305,582	$15,787	$195	0.06%	1.2%
594	Misc. shopping goods strs.	100	$23,314,245	$46,836,435	$506,822	2.6%	$1,236,483	$13,380	$195	0.04%	1.5%
596	Nonstore retailers	100	$8,364,985	$21,621,142	$831,934	2.5%	$537,863	$20,696	$291	0.03%	1.4%
598	Fuel dealers	100	$3,969,173	$11,265,014	$1,502,002	1.8%	$206,800	$27,573	$380	0.03%	1.4%
599	Retail stores, n.e.c.	100	$10,948,496	$30,053,132	$392,251	3.2%	$969,091	$12,649	$123	0.03%	1.0%
601	Central res. depository	10	$1,382	$126,998	$25,399,600	10.8% [d]	$13,716	$2,743,157	$115	0.00%	0.0%
602	Commercial banks	10	$3,375,263	$1,624,224	$1,727,898	10.8% [d]	$175,416	$186,613	$103	0.01%	0.1%
603	Savings institutions	10	$903,024	$608,115	$1,974,399	10.8% [d]	$65,676	$213,235	$106	0.01%	0.0%
606	Credit unions	10	$773,380	$3,506,092	$494,582	10.8% [d]	$378,658	$53,415	$74	0.01%	0.1%
608	Foreign banking	10	$16,908	$343,106	$6,126,893	10.8% [d]	$37,055	$661,704	$92	0.00%	0.0%
609	Banking-related functions	100	$666,547	$2,929,885	$918,459	10.8% [d]	$316,428	$99,194	$142	0.02%	0.1%
611	Federal credit agencies	20	$107,461	$127,485	$1,722,770	10.8%	$13,768	$186,059	$96	0.01%	0.1%
614	Personal cred. institutions	20	$1,412,949	$3,486,159	$856,550	15.5% [d]	$539,193	$132,480	$82	0.01%	0.1%
615	Business cred. institutions	20	$450,801	$4,947,066	$1,814,771	17.1% [d]	$844,648	$309,849	$99	0.01%	0.0%

Table VIII-4 Estimated Economic Impact Under Worst-Case Scenarios, of the Ergonomics Program Standard on Firms Meeting SBA Size Criteria

SIC	Industry	SBA size (Number of Employees)*	Annualized Compliance Costs for SBA Establishments	Revenues for SBA Firms ($1,000s)	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [c]	Profits for SBA Firms ($1,000s)	Average Profit per Firm (SBA) ($)	For all small firms: Average Cost per Firm (SBA) ($)	For all small firms: Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	For all small firms: Annualized Compliance Costs as a Percentage of Profits--SBA (percent)
616	Mortgage bankers & brokers	100	$2,755,682	$9,629,490	$695,722	11.7%	$1,122,225	$81,080	$134	0.02%	0.2%
621	Security brokers & dealers	20	$1,957,465	$6,612,505	$842,572	12.8%	$844,196	$107,568	$93	0.01%	0.1%
622	Commodity contracts brokers	100	$144,311	$1,550,654	$1,061,365	13.3%	$206,476	$141,325	$92	0.01%	0.1%
623	Security & commod. exchanges	100	$21,567	$110,466	$1,600,957	13.3%	$14,709	$213,174	$211	0.01%	0.1%
628	Security & commod. services	100	$1,824,210	$12,130,210	$731,044	15.3% [d]	$1,858,605	$112,011	$103	0.01%	0.1%
631	Life insurance	100	$3,311,304	$7,677,233	$7,739,146	6.8% [d]	$523,844	$528,069	$326	0.00%	0.1%
632	Medical & health insur.	20	$283,761	$2,824,245	$4,637,512	3.6%	$101,867	$167,270	$139	0.00%	0.1%
633	Fire, marine, & caslty ins.	1500	$12,674,215	$304,968,860	$140,086,752	9.1% [d]	$27,599,682	$12,677,851	$5,830	0.00%	0.0%
635	Surety insurance	20	$53,081	$425,650	$2,086,520	6.8%	$29,044	$142,370	$110	0.01%	0.1%
636	Title insurance	100	$576,728	$379,969	$628,048	4.6%	$17,289	$28,576	$243	0.04%	0.9%
637	Pension and health funds	1000	$607,997	$1,884,439	$758,021	6.8% [f]	$128,582	$51,722	$240	0.03%	0.5%
639	Ins. carriers, n.e.c.	100	$59,485	$435,319	$1,836,789	6.8%	$29,703	$125,331	$213	0.01%	0.2%
641	Insurance agents	100	$11,945,677	$43,627,225	$376,269	6.8% [d]	$2,977,558	$25,680	$98	0.03%	0.4%
651	Real estate operators	100	$12,232,921	$68,368,940	$723,466	14.1% [d]	$9,619,754	$101,794	$126	0.02%	0.1%
653	RE agents and managers	100	$13,395,872	$50,958,708	$452,717	13.2%	$6,739,289	$59,872	$112	0.02%	0.2%
654	Title abstract offices	100	$590,586	$1,983,347	$450,454	13.3% [e]	$263,972	$59,953	$124	0.03%	0.2%
655	Subdividers & developers	100	$2,691,622	$11,839,645	$686,118	10.6%	$1,256,055	$72,789	$147	0.02%	0.2%
671	Holding offices	100	$1,602,500	$9,312,324	$1,458,012	25.4%	$2,363,917	$370,114	$175	0.01%	0.0%
672	Investment offices	20	$65,503	$1,718,384	$2,504,933	20.4%	$351,041	$511,722	$78	0.00%	0.0%
673	Trusts	100	$956,791	$8,081,507	$964,611	24.3%	$1,963,604	$234,376	$111	0.01%	0.0%
679	Miscellaneous investing	20	$667,358	$9,524,886	$1,309,443	21.5%	$2,051,829	$282,077	$85	0.01%	0.0%
701	Hotels and motels	100	$15,659,677	$20,248,760	$562,982	7.0%	$1,407,289	$39,127	$379	0.07%	1.0%
702	Rooming & boarding houses	1000	$126,188	$427,076	$274,294	7.0%	$29,727	$19,092	$81	0.03%	0.4%
703	Camps and rec. vehicle parks	1000	$356,537	$2,820,658	$403,297	7.3%	$206,909	$29,584	$51	0.01%	0.2%
704	Membership-basis org. hotels	100	$158,700	$498,571	$216,959	7.0% [d]	$34,703	$15,101	$66	0.03%	0.4%
721	Laundry & garment srvices	100	$15,357,312	$12,383,614	$247,311	5.9%	$734,487	$14,668	$293	0.12%	2.0%
722	Photo studios, portrait	500	$1,123,994	$2,406,763	$278,014	4.5% [d]	$108,304	$12,511	$90	0.03%	0.7%
723	Beauty shops	500	$5,279,870	$10,443,876	$142,666	4.4%	$459,531	$6,277	$69	0.05%	1.1%
724	Barber shops	100	$589,116	$350,653	$82,197	5.9%	$20,531	$4,813	$134	0.16%	2.8%
725	Shoe repair	100	$254,036	$209,963	$101,726	5.9%	$12,293	$5,956	$123	0.12%	2.1%
726	Fun. service and crematories	100	$2,406,472	$7,073,950	$590,431	7.6% [d]	$534,083	$44,578	$176	0.03%	0.4%
729	Misc personal services.	500	$2,469,966	$5,563,729	$212,827	6.6% [d]	$365,214	$13,970	$88	0.04%	0.6%
731	Advertising	100	$3,327,317	$13,539,451	$765,849	3.9%	$528,472	$29,893	$176	0.02%	0.6%
732	Credit report.& collection	100	$1,486,449	$3,895,290	$674,626	5.4%	$211,608	$36,648	$230	0.03%	0.6%
733	Mailing, reprod, steno., serv	100	$5,253,896	$16,758,103	$500,227	4.7%	$790,696	$23,602	$153	0.03%	0.6%
734	Services to buildings	500	$12,320,964	$16,369,158	$258,731	3.5%	$576,621	$9,114	$192	0.07%	2.1%
735	Misc. equipt. rental	100	$5,598,634	$16,405,858	$985,159	8.8%	$1,451,030	$87,133	$254	0.03%	0.3%
736	Pers. supply services	500	$31,666,138	$27,321,192	$1,103,842	3.3%	$891,299	$36,011	$923	0.08%	2.6%
737	Comptr & data proc. services	500	$23,326,437	$84,991,310	$1,097,682	4.9%	$4,198,029	$54,218	$274	0.02%	0.5%
738	Misc. business services	500	$18,083,738	$43,556,800	$557,848	5.1%	$2,209,369	$28,296	$219	0.04%	0.8%
751	Auto rentals, no drivers	100	$2,702,854	$6,258,032	$1,154,193	5.4%	$340,984	$62,889	$282	0.02%	0.4%
752	Automobile parking	100	$1,249,889	$1,382,755	$682,842	4.4%	$60,743	$29,996	$194	0.03%	0.6%
753	Automotive repair shops	500	$26,239,345	$49,806,400	$374,580	3.9%	$1,922,538	$14,459	$194	0.05%	1.3%
754	Automotive serv., exc repair	500	$8,761,572	$8,124,818	$349,680	4.4% [d]	$360,539	$15,517	$355	0.10%	2.3%
762	Electrical repair shops	100	$4,811,885	$6,556,781	$384,314	4.6%	$303,972	$17,817	$258	0.07%	1.4%
763	Watch and jewelry repair	100	$272,152	$253,189	$156,483	5.4%	$13,763	$8,506	$155	0.10%	1.8%
764	Reupholstery & furn. repair	100	$839,530	$1,047,917	$149,960	5.4%	$56,963	$8,151	$123	0.08%	1.5%
769	Misc. repair shops	100	$9,861,707	$17,143,114	$456,359	5.9% [d]	$1,004,096	$26,730	$257	0.06%	1.0%
781	Motion picture production	500	$4,557,763	$14,127,803	$990,868	4.7% [d]	$665,423	$46,670	$316	0.03%	0.7%
782	Motion picture dist.	20	$287,154	$1,562,938	$1,444,490	5.1%	$80,301	$74,216	$237	0.02%	0.3%

Table VIII-4 Estimated Economic Impact Under Worst-Case Scenarios, of the Ergonomics Program Standard on Firms Meeting SBA Size Criteria

SIC	Industry	SBA size (Number of Employees)*	Annualized Compliance Costs for SBA Establishments	Revenues for SBA Firms ($1,000s)	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [c]	Profits for SBA Firms ($1,000s)	Average Profit per Firm (SBA) ($)	For all small firms: Average Cost per Firm (SBA) ($)	For all small firms: Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	For all small firms: Annualized Compliance Costs as a Percentage of Profits--SBA (percent)
783	Motion picture theaters	100	$5,380,995	$1,627,994	$652,241	6.3%	$101,872	$40,814	$953	0.15%	2.3%
784	Video tape rental	500	$5,724,517	$4,284,059	$297,050	5.9% [d]	$251,688	$17,452	$320	0.11%	1.8%
791	Dance studios & schools	100	$409,328	$845,705	$147,902	4.3%	$36,197	$6,330	$73	0.05%	1.1%
792	Prducrs, orch., entertainers	100	$2,311,655	$11,792,304	$713,474	4.6%	$544,113	$32,921	$141	0.02%	0.4%
793	Bowling centers	500	$1,841,053	$2,462,213	$480,995	3.8% [d]	$92,333	$18,037	$335	0.07%	1.9%
794	Commercial sports	100	$1,184,286	$4,728,679	$1,064,778	3.5%	$163,139	$36,735	$265	0.02%	0.7%
799	Misc. recreation services	500	$19,801,515	$35,023,969	$602,501	4.4%	$1,557,624	$26,795	$330	0.05%	1.2%
801	Offices of medical doctors	100	$36,638,497	$131,952,442	$775,789	6.4%	$8,411,968	$49,457	$205	0.03%	0.4%
802	Dentists offices and clinics	500	$19,070,551	$45,912,607	$413,582	10.5%	$4,797,867	$43,219	$173	0.04%	0.4%
803	Osteopathic physicians	500	$1,004,631	$4,430,862	$501,172	13.4% [e]	$592,628	$67,032	$113	0.02%	0.2%
804	Other health practitioners	500	$13,362,402	$23,599,395	$289,816	7.4%	$1,741,167	$21,383	$164	0.06%	0.8%
805	Nursing & personal care fac.	500	$70,773,606	$32,982,123	$2,533,384	4.7%	$1,562,701	$120,032	$3,639	0.14%	3.0%
806	Hospitals	100	$2,026,070	$2,302,427	$2,933,028	5.5%	$126,536	$161,193	$1,570	0.05%	1.0%
807	Med. & dental labs	100	$3,318,284	$7,006,641	$567,385	7.2%	$503,162	$40,745	$227	0.04%	0.6%
808	Home hlth care services	500	$21,052,841	$12,958,725	$1,352,121	3.2%	$411,440	$42,930	$1,451	0.11%	3.4%
809	Hlth & allied serv., n.e.c.	500	$10,860,311	$15,621,054	$1,242,429	6.7%	$1,047,168	$83,287	$678	0.05%	0.8%
811	Legal services	100	$19,269,826	$81,107,226	$499,601	17.5%	$14,193,765	$87,430	$117	0.02%	0.1%
821	Elem. & secondary schools	100	$8,616,052	$16,867,241	$1,176,073	5.9% [e]	$990,950	$69,094	$526	0.04%	0.8%
822	Colleges & universities	100	$1,391,127	$2,098,528	$1,325,665	9.1%	$191,765	$121,140	$620	0.05%	0.5%
823	Libraries	1000	$416,234	$846,367	$390,031	8.1%	$68,908	$31,755	$208	0.05%	0.7%
824	Vocational schools	100	$1,085,300	$3,323,253	$557,312	6.3%	$209,773	$35,179	$169	0.03%	0.5%
829	Schools, n.e.c.	1000	$2,333,497	$7,437,108	$500,377	5.5% [d]	$405,322	$27,271	$163	0.03%	0.6%
832	Individual & fam. services	500	$13,588,716	$20,916,304	$609,148	4.5%	$936,005	$27,259	$392	0.06%	1.4%
333	Job train. & related serv.	500	$5,298,093	$6,547,702	$1,095,666	3.4%	$222,622	$37,253	$792	0.07%	2.1%
835	Child day care services	1000	$9,313,638	$12,459,047	$266,652	4.7%	$579,346	$12,399	$210	0.08%	1.7%
836	Residential care	500	$14,968,870	$15,907,526	$860,750	3.4%	$544,833	$29,481	$742	0.09%	2.5%
839	Social services, n.e.c.	100	$2,754,187	$11,627,201	$982,940	5.3%	$616,242	$52,096	$196	0.02%	0.4%
841	Museums & art galleries	100	$810,393	$1,709,385	$413,094	21.5%	$366,663	$88,609	$189	0.05%	0.2%
842	Bot. & zoology gardens	100	$142,698	$287,990	$580,625	21.5%	$61,774	$124,544	$267	0.05%	0.2%
861	Business associations	100	$2,025,380	$9,917,916	$658,954	3.9%	$390,105	$25,919	$133	0.02%	0.5%
862	Prof. organizations	100	$872,860	$4,918,054	$732,835	4.9% [d]	$240,985	$35,909	$128	0.02%	0.4%
863	Labor organizations	100	$2,112,425	$8,070,501	$432,735	8.6%	$694,063	$37,215	$111	0.03%	0.3%
864	Civic & social assoc.	500	$8,047,968	$13,342,095	$382,131	4.3%	$567,039	$16,241	$227	0.06%	1.4%
865	Political organizations	100	$272,990	$927,341	$362,243	7.2%	$66,875	$26,123	$107	0.03%	0.4%
866	Religious organizations	500	$20,541,633	$51,886,479	$328,231	8.9%	$4,604,925	$29,131	$130	0.04%	0.4%
869	Membership orgs., n.e.c.	100	$1,689,900	$3,563,108	$482,414	8.5% [d]	$302,864	$41,005	$195	0.04%	0.5%
871	Eng. and arch. services	100	$15,340,961	$45,567,185	$647,979	4.6%	$2,102,880	$29,904	$203	0.03%	0.7%
872	Accntng, auditng, & bkeeping	100	$11,863,028	$26,143,611	$324,342	12.0%	$3,124,162	$38,759	$144	0.04%	0.4%
873	Research & testing services	100	$6,452,524	$14,718,882	$976,053	4.9%	$724,281	$48,029	$361	0.04%	0.8%
874	Management & pub. relations	100	$13,995,542	$47,280,827	$540,229	6.3%	$2,958,208	$33,800	$152	0.03%	0.4%
899	Services, n.e.c.	100	$3,076,066	$7,439,380	$470,966	6.8%	$505,878	$32,026	$184	0.04%	0.6%
	Subtotal		**$1,932,484,250**	**$6,991,680,900**			**$6,752,017,933**				
	Average (weighted)		**$25,822,860**	**$58,383,316**	**$1,478,510**	**5.8%**	**$2,978,220**	**$70,228**	**$331**	**0.04%**	**1.0%**
	State & Local Government		$145,562,362	$101,000,000	$5,841,865	na	na	na	$6,473	0.12%	na
	Total		**$2,078,046,612**	**$7,092,680,900**							

Table VIII-4 Estimated Economic Impact Under Worst-Case Scenarios, of the Ergonomics Program Standard on Firms Meeting SBA Size Criteria

										For all small firms	
SIC	Industry	SBA size (Number of Employees)*	Annualized Compliance Costs for SBA Establishments	Revenues for SBA Firms ($1,000s)	Average Revenue per Firm (SBA)	Profits as a Percentage of Revenues [c]	Profits for SBA Firms ($1,000s)	Average Profit per Firm (SBA) ($)	Average Cost per Firm (SBA) ($)	Annualized Compliance Costs as a Percentage of Revenues--SBA (percent)	Annualized Compliance Costs as a Percentage of Profits--SBA (percent)

Source: Office of Regulatory Analysis.
Revenue data are from U.S. Dept. of Commerce, Bureau of Census. Compliance costs are from Chapter V of this Final Economic Analysis. Profit data are derived from Robert Morris Associates, RMA Annual Statement Studies 1995-1998 (RMA) and U.S. Department of the Treasury, 1995-1997 (IRS). Average profit rates for the period 1995 through 1998 were calculated from a weighted average of profit rates over this period for all 4-digit industries associated with each 3-digit SIC classification. Revenues were used as weights in this calculation.

* Approximated, to make use of available firm revenue data.
[a] Excludes SIC 3731
[b] Revenue data was wholely or partially suppressed by the Census Bureau for the SBA small entity size category. Any projected economic impacts are therefore overestimated for these industries.
Where estimated costs as a percent of profits would be in excess of 20 percent, revenues and profits are reported as "na", because the high impact is at least partially the direct result of revenue data supression.
[c] Profit rates, except where noted, are derived from Robert Morris Associates ' "RMA Studies."
[d] Profit data not available for all 4-digit industries in this classification; profit rates interpolated from a combination of RMA and IRS profit data.
[e] Based on a combination of RMA and IRS profit data.
[f] Based on IRS profit data.

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

								For all very small firms		
SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
074	Veterinary services	$5,151,445	$5,804,263	$272,770	6.1%	$356,250	$16,742	$240	0.09%	1.4%
075	Animal serv., excpt vet.	$789,694	$1,003,467	$99,383	6.0% [d]	$60,394	$5,981	$78	0.08%	1.3%
078	Lndscape & hort. services	$9,039,804	$9,790,176	$150,990	5.9%	$573,809	$8,850	$139	0.09%	1.6%
081	Timber tracts	$118,388	$248,523	$430,716	10.3% [d]	$25,598	$44,364	$147	0.03%	0.3%
083	Forest products	$18,386	$55,299	$650,576	10.3% [d]	$5,696	$67,009	$155	0.02%	0.2%
085	Forestry services	$228,614	$320,917	$316,174	10.3% [d]	$33,054	$32,566	$161	0.05%	0.5%
091	Commerical fishing	$157,232	$437,580	$307,722	5.7% [d]	$25,130	$17,672	$83	0.03%	0.5%
092	Fish hatcheries	$11,056	$17,947	$309,431	6.1% [d]	$1,101	$18,983	$147	0.05%	0.8%
097	Hunting & trapping	$38,532	$55,959	$233,163	6.1% [d]	$3,433	$14,304	$122	0.05%	0.9%
131	Crude petrol. & nat. gas	$1,054,800	$10,314,646	$1,572,834	8.7%	$892,217	$136,050	$151	0.01%	0.1%
132	Natural gas liquids	$38,456	$425,191	$11,189,237	8.7% [d]	$36,779	$967,869	$111	0.00%	0.0%
138	Oil & gas field services	$1,079,535	$2,650,444	$380,756	8.7%	$229,263	$32,935	$147	0.04%	0.4%
201	Meat products	$271,939	$1,877,869	$1,144,344	2.6%	$47,950	$29,220	$163	0.01%	0.6%
202	Dairy products	$212,096	$1,265,505	$1,656,420	3.4%	$43,497	$56,934	$262	0.02%	0.5%
203	Presrvd fruits & vegetables	$161,062	$1,152,014	$1,252,189	4.0%	$45,925	$49,919	$162	0.01%	0.3%
204	Grain mill products	$470,039	$2,614,381	$2,389,745	3.3%	$86,329	$78,911	$322	0.01%	0.4%
205	Bakery products	$466,574	$933,319	$443,171	3.7%	$34,280	$16,277	$221	0.05%	1.4%
206	Sugar and confect. prods	$147,308	$523,156	$894,284	3.6%	$19,012	$32,499	$248	0.03%	0.8%
207	Fats and oils	$59,784	$513,533	$3,721,254	3.5% [d]	$17,786	$128,884	$325	0.01%	0.3%
208	Beverages	$336,064	$3,572,609	$2,952,569	4.7% [e]	$169,318	$139,932	$264	0.01%	0.2%
209	Misc. food products	$600,563	$2,193,235	$918,440	3.1% [e]	$68,647	$28,747	$235	0.03%	0.8%
211	Cigarettes	$1,247	na	na [b]	4.0% [d]	na	na	$312	na	na
212	Cigars	$3,217	na	na [b]	4.0% [d]	na	na	$111	na	na
213	Chewing & smoking tobacco	$1,775	$12,757	$1,063,083 [b]	4.0% [d]	$512	$42,706	$197	0.02%	0.5%
214	Tobacco stemm. & redrying	$596	na	na [b]	4.0% [d]	na	na	$119	na	na
221	Brdwven fab. mills, cotton	$39,174	$142,493	$489,667	4.0%	$5,628	$19,342	$143	0.03%	0.7%
222	Broadwoven fabric mills	$31,755	$73,125	$358,456	2.8% [e]	$2,024	$9,923	$160	0.04%	1.6%
223	Brdwvn fab. mills, wool	$6,706	$35,441	$770,457	2.8% [e]	$981	$21,327	$156	0.02%	0.7%
224	Narrow fabric mills	$40,063	$86,915	$643,815	3.2%	$2,760	$20,441	$306	0.05%	1.5%
225	Knitting mills	$181,845	$685,286	$728,253	2.9%	$19,673	$20,906	$199	0.03%	1.0%
226	Tex. finishing, excpt wool	$83,791	$332,025	$639,740	2.8%	$9,309	$17,937	$162	0.03%	0.9%
227	Carpets and rugs	$46,514	$243,800	$820,875	2.8%	$6,765	$22,779	$162	0.02%	0.7%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

								For all very small firms		
SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
228	Yarn and thread mills	$31,426	$128,733	$825,212	2.0%	$2,531	$16,225	$203	0.02%	1.2%
229	Misc. textile goods	$137,316	$419,588	$817,910	2.8% [e]	$11,819	$23,040	$266	0.03%	1.2%
231	Men's & boys' suits & coats	$20,839	$108,397	$747,566	0.9% [e]	$1,003	$6,915	$150	0.02%	2.2%
232	Men's & boys' furnishings	$128,664	$461,072	$571,341	2.7%	$12,522	$15,517	$173	0.03%	1.1%
233	Wm's & misses' outerwear	$822,777	$2,792,289	$440,841	2.6%	$72,027	$11,371	$138	0.03%	1.2%
234	Wm's & chldrn's undergarmn	$23,362	$160,401	$1,055,270	2.4% [e]	$3,873	$25,479	$158	0.01%	0.6%
235	Hats, caps, & millinery	$29,693	$67,989	$298,197	3.9%	$2,669	$11,704	$147	0.05%	1.3%
236	Girls' & chldrn's outerwear	$28,852	$207,601	$766,055	2.0%	$4,099	$15,126	$111	0.01%	0.7%
237	Fur goods	$18,676	$112,866	$842,284	2.6%	$2,887	$21,547	$146	0.02%	0.7%
238	Misc. apparel & accessories	$97,561	$245,271	$376,760	2.6% [e]	$6,303	$9,681	$160	0.04%	1.7%
239	Misc. fab. textile prods	$1,000,283	$2,731,530	$373,211	2.6%	$71,292	$9,741	$147	0.04%	1.5%
241	Logging	$1,472,488	$8,572,706	$631,460	3.9% [f]	$334,249	$24,621	$108	0.02%	0.4%
242	Sawmills & planing mills	$1,123,461	$2,523,245	$632,392	4.3%	$108,370	$27,160	$274	0.04%	1.0%
243	Millwork & plywood	$2,094,230	$3,501,543	$493,106	3.6%	$126,134	$17,763	$292	0.06%	1.6%
244	Wood containers	$589,916	$1,047,315	$513,390	3.7%	$38,349	$18,798	$284	0.06%	1.5%
245	Wood bldings & mobile hom	$157,439	$366,648	$733,296	3.8%	$13,777	$27,554	$296	0.04%	1.1%
249	Misc. wood products	$668,565	$1,467,850	$592,114	3.9% [e]	$56,888	$22,948	$260	0.04%	1.1%
251	Household furniture	$836,201	$1,575,196	$400,304	3.2%	$50,401	$12,809	$221	0.06%	1.7%
252	Office furniture	$163,358	$304,623	$503,509	3.8%	$11,682	$19,309	$274	0.05%	1.4%
253	Pub blding & related furn.	$92,516	$145,783	$659,652	4.1%	$5,941	$26,881	$424	0.06%	1.6%
254	Partitions and fixtures	$652,165	$1,146,102	$526,943	3.7%	$42,571	$19,573	$314	0.06%	1.6%
259	Misc furniture and fixtures	$220,968	$552,452	$562,578	3.2%	$17,412	$17,731	$226	0.04%	1.3%
261	Pulp mills	$2,411	$25,433	$1,816,643	4.5%	$1,145	$81,766	$151	0.01%	0.2%
262	Paper mills	$14,733	$38,880	$777,600	4.8% [e]	$1,847	$36,936	$268	0.03%	0.7%
263	Paperboard mills	$6,569	$29,935	$1,496,750	4.5% [d]	$1,347	$67,368	$299	0.02%	0.4%
265	Paperbrd containers & boxes	$319,902	$807,982	$1,241,140	4.6%	$36,928	$56,725	$438	0.04%	0.8%
267	Misc. cnvrtd paper products	$483,400	$1,336,339	$1,113,616	4.3%	$57,525	$47,938	$376	0.03%	0.8%
271	Newspapers	$1,471,842	$1,714,050	$304,179	3.8% [d]	$65,126	$11,557	$236	0.08%	2.0%
272	Periodicals	$658,040	$3,103,426	$660,163	3.8%	$117,930	$25,086	$137	0.02%	0.5%
273	Books	$450,631	$1,681,873	$614,944	4.5% [e]	$75,377	$27,560	$165	0.03%	0.6%
274	Miscellaneous publishing	$416,297	$1,526,840	$609,274	4.5%	$68,326	$27,265	$158	0.03%	0.6%
275	Commercial printing	$6,673,174	$12,327,939	$425,718	3.4%	$424,513	$14,660	$233	0.05%	1.6%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

								For all very small firms		
SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
276	Manifold business forms	$141,644	$292,443	$790,386	3.4%	$9,797	$26,478	$348	0.04%	1.3%
277	Greeting cards	$20,939	$53,804	$632,988	3.8% [d]	$2,044	$24,051	$249	0.04%	1.0%
278	Blankbooks & bookbinding	$266,869	$329,528	$344,334	3.9%	$12,977	$13,560	$285	0.08%	2.1%
279	Printing trade services	$531,405	$995,290	$366,995	3.6% [e]	$35,638	$13,141	$197	0.05%	1.5%
281	Indust. inorganic chemicals	$177,758	$594,096	$2,007,081	4.5% [e]	$26,705	$90,219	$208	0.01%	0.2%
282	Plastics mat. & synthetics	$64,940	$609,615	$2,018,593	4.5%	$27,406	$90,749	$188	0.01%	0.2%
283	Drugs	$180,906	$1,440,652	$1,844,625	4.8%	$68,957	$88,293	$215	0.01%	0.2%
284	Soap, clnrs, & toilet goods	$326,449	$2,323,726	$1,490,523	4.4%	$102,273	$65,602	$200	0.01%	0.3%
285	Paints & allied products	$183,004	$1,196,898	$1,492,392	3.8%	$44,884	$55,965	$201	0.01%	0.4%
286	Indust. organic chemicals	$89,175	$738,264	$2,828,598	4.5%	$33,130	$126,933	$254	0.01%	0.2%
287	Agricultural chemicals	$125,165	$1,087,188	$2,363,452	3.8%	$41,007	$89,145	$205	0.01%	0.2%
289	Misc. chemical products	$400,674	$2,355,395	$2,101,155	4.8% [e]	$112,039	$99,945	$259	0.01%	0.3%
291	Petroleum refining	$22,693	$349,271	$5,213,000	2.9%	$9,954	$148,571	$265	0.01%	0.2%
295	Asphlt pavng & roofng mat.	$338,763	$1,324,706	$3,561,038	3.9%	$51,896	$139,506	$318	0.01%	0.2%
299	Misc. pet. & coal prods	$62,694	$532,622	$2,477,312	4.7%	$25,238	$117,388	$227	0.01%	0.2%
301	Tires and inner tubes	$22,891	$59,384	$899,758	4.0% [d]	$2,390	$36,213	$297	0.03%	0.8%
302	Rubber & plastics footwear	$2,944	$11,055	$502,500	4.0% [d]	$445	$20,225	$134	0.03%	0.7%
305	Hose, bltng, and gaskets	$105,698	$372,073	$1,045,149	4.0%	$14,871	$41,773	$266	0.03%	0.6%
306	Fab. rubber prod., n.e.c.	$211,917	$542,778	$708,587	4.0%	$21,846	$28,519	$248	0.04%	0.9%
308	Misc plastics, n.e.c.	$1,486,130	$5,293,162	$865,178	4.0%	$213,152	$34,840	$226	0.03%	0.6%
311	Leather tan. & finishing	$65,806	$141,491	$643,141	1.7%	$2,441	$11,094	$294	0.05%	2.6%
313	Footwear cut stock	$13,506	na	na [b]	2.2% [d]	na	na	$300	na	na
314	Footwear, except rubber	$43,109	$109,113	$574,279	2.3%	$2,557	$13,459	$232	0.04%	1.7%
315	Leather gloves & mittens	$13,339	na	na [b]	2.2% [d]	$0	$0	$394	na	na
316	Luggage	$25,164	$49,333	$310,270 [b]	2.9%	$1,443	$9,075	$162	0.05%	1.8%
317	Hndbags & prsnal leathr gds.	$36,710	$72,877	$269,915 [b]	2.2% [d]	$1,601	$5,929	$139	0.05%	2.3%
319	Leather goods, n.e.c.	$76,094	$105,290	$326,988	2.2% [f]	$2,313	$7,183	$234	0.07%	3.3%
321	Flat glass	$9,736	$12,089	$318,132	4.9% [d]	$596	$15,673	$256	0.08%	1.6%
322	Glass, pressed or blown	$114,780	$185,728	$470,197	4.9% [f]	$9,150	$23,165	$287	0.06%	1.2%
323	Prod. of purchased glass	$261,092	$488,592	$426,346	5.1%	$24,674	$21,530	$224	0.05%	1.0%
324	Cement, hydraulic	$31,472	$125,857	$1,498,298	4.9% [d]	$6,201	$73,816	$306	0.02%	0.4%
325	Structural clay products	$79,648	$130,451	$550,426	5.4%	$7,023	$29,634	$293	0.05%	1.0%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	For all very small firms: Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
326	Pottery & related prods	$179,618	$198,286	$219,343	4.9% [d]	$9,769	$10,806	$199	0.09%	1.8%
327	Concrete & plast. prdcts	$2,438,900	$4,341,440	$1,046,130	4.8%	$209,619	$50,511	$371	0.04%	0.7%
328	Cut stone & stone prods	$255,532	$426,840	$488,375	5.0%	$21,449	$24,541	$287	0.06%	1.2%
329	Misc. nonmet. mineral prods.	$263,699	$648,078	$859,520	5.0% [e]	$32,095	$42,566	$280	0.03%	0.7%
331	Basic steel products	$140,857	$636,677	$1,329,180	4.3%	$27,415	$57,234	$260	0.02%	0.5%
332	Iron and steel foundries	$110,493	$275,374	$697,149	4.6%	$12,546	$31,763	$266	0.04%	0.8%
333	Primary nonfer. metals	$21,091	$155,290	$1,617,604	4.5% [d]	$7,016	$73,078	$215	0.01%	0.3%
334	Secondary nonfer. metals	$40,691	$272,687	$2,310,907	3.9%	$10,567	$89,548	$302	0.01%	0.3%
335	Nonfer. rolling & drawing	$89,176	$369,944	$1,254,047	4.9%	$17,988	$60,976	$265	0.02%	0.4%
336	Nonfer. foundries (cstngs)	$250,287	$545,378	$637,869	4.5%	$24,517	$28,675	$284	0.04%	1.0%
339	Misc. primary metal prdcts	$130,568	$345,464	$818,635	4.8%	$16,732	$39,650	$266	0.03%	0.7%
341	Met. cans & ship. containers	$47,709	$148,512	$1,207,415	4.1%	$6,019	$48,937	$322	0.03%	0.7%
342	Cutlery, hndtls, & hardware	$389,610	$866,269	$612,204	4.6% [e]	$39,942	$28,228	$263	0.04%	0.9%
343	Plumbing & heating fixtures	$117,467	$276,437	$733,255	4.8%	$13,190	$34,985	$298	0.04%	0.9%
344	Fab. struct. metal prdcts	$2,361,727	$6,222,867	$789,403	4.3%	$266,530	$33,811	$286	0.04%	0.8%
345	Screw machine products	$514,824	$957,063	$689,527	4.4%	$42,321	$30,490	$358	0.05%	1.2%
346	Met. forgings & stampings	$588,066	$1,402,160	$866,601	4.6%	$64,025	$39,570	$346	0.04%	0.9%
347	Metal services, n.e.c.	$1,080,599	$1,953,183	$540,898	5.0%	$96,694	$26,778	$289	0.05%	1.1%
348	Ordnance and access., n.e.c.	$66,988	$118,616	$396,709	4.5% [d]	$5,392	$18,035	$223	0.06%	1.2%
349	Misc. fab. metal products	$1,212,012	$3,119,176	$713,770	4.9%	$152,645	$34,930	$267	0.04%	0.8%
351	Engines and turbines	$51,477	$136,227	$846,130	4.0% [d]	$5,511	$34,232	$298	0.04%	0.9%
352	Farm & garden machinery	$338,138	$753,582	$671,642	4.7%	$35,619	$31,746	$292	0.04%	0.9%
353	Construct. & related mach.	$504,736	$1,531,656	$863,878	4.3%	$66,240	$37,360	$270	0.03%	0.7%
354	Metalworking machinery	$2,336,714	$4,596,589	$552,940	4.6%	$211,014	$25,384	$274	0.05%	1.1%
355	Special industry mach.	$744,270	$2,252,354	$781,254	4.1%	$91,422	$31,711	$248	0.03%	0.8%
356	General indust. mach.	$644,474	$1,816,610	$835,223	4.3%	$78,850	$36,253	$275	0.03%	0.8%
357	Computer & office equip.	$268,787	$1,479,035	$1,146,539	3.3%	$48,696	$37,749	$201	0.02%	0.5%
358	Refrig. & serv. indust mach.	$325,100	$961,953	$825,003	3.6%	$34,573	$29,651	$268	0.03%	0.9%
359	Industrial mach., n.e.c.	$4,939,738	$8,880,402	$421,311	5.1% [e]	$449,154	$21,309	$232	0.06%	1.1%
361	Elect. dist. equipment	$99,387	$377,070	$828,725	5.2%	$19,504	$42,867	$209	0.03%	0.5%
362	Elect. indust. apparatus	$276,486	$955,829	$757,993	5.1%	$49,127	$38,959	$211	0.03%	0.5%
363	Household appliances	$46,400	$189,966	$829,546	5.6% [d]	$10,622	$46,383	$198	0.02%	0.4%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	For all very small firms: Annualized Costs per Firm	For all very small firms: Annualized Costs as a Percent of Revenues	For all very small firms: Annualized Costs as a Percent of Profits
364	Elct. lghtng & wire equip.	$235,582	$824,155	$737,829	5.7%	$47,236	$42,288	$205	0.03%	0.5%
365	Household audio & vid. equi	$91,003	$573,801	$1,048,996	5.0%	$28,864	$52,768	$164	0.02%	0.3%
366	Communications equipment	$194,392	$1,074,776	$961,338	5.8% [e]	$61,851	$55,323	$168	0.02%	0.3%
367	Electrnic compnnts & access.	$540,756	$2,445,955	$739,183	5.6%	$136,466	$41,241	$160	0.02%	0.4%
369	Misc. elect. equipment	$188,235	$659,045	$745,526	5.9% [e]	$38,821	$43,915	$203	0.03%	0.5%
371	Motor vehicles & equipt.	$773,827	$2,145,214	$820,036	3.5%	$75,114	$28,713	$283	0.03%	1.0%
372	Aircraft and parts	$223,070	$629,436	$715,268	4.7% [e]	$29,367	$33,371	$244	0.03%	0.7%
[a] 373	Ship, boat blding and repair[	$575,944	$983,829	$377,960	3.6%	$35,833	$13,766	$255	0.07%	1.9%
374	Railroad equipment	$16,444	$62,657	$1,010,597	3.7%	$2,303	$37,139	$211	0.02%	0.6%
375	Motorcycles & bicycles	$57,195	$208,190	$746,201	3.7%	$7,793	$27,931	$204	0.03%	0.7%
376	Guided missiles	$8,831	$19,397	$570,490	3.7%	na	na	$245	0.04%	na
379	Misc. transportation equip.	$133,629	$514,035	$712,947	3.7% [e]	$18,799	$26,073	$181	0.03%	0.7%
381	Srch & navigation equipment	$56,912	$183,208	$555,176	4.7% [e]	$8,611	$26,093	$164	0.03%	0.6%
382	Meas. & contrlling devices	$538,189	$2,196,915	$789,689	5.6%	$123,365	$44,344	$186	0.02%	0.4%
384	Medical instrmnts & supplies	$457,710	$2,382,591	$861,697	5.3% [e]	$126,580	$45,779	$159	0.02%	0.3%
385	Ophthalmic goods	$64,238	$178,836	$451,606	3.7%	$6,572	$16,597	$153	0.03%	0.9%
386	Photo. equip. & supplies	$82,559	$407,370	$864,904	4.0%	$16,295	$34,596	$169	0.02%	0.5%
387	Watches, clocks, & parts	$10,190	$33,895	$356,789	5.1% [d]	$1,715	$18,057	$102	0.03%	0.6%
391	Jwlry, slvrwre, and plate	$290,301	$1,468,531	$597,693	3.3%	$48,894	$19,900	$121	0.02%	0.6%
393	Musical instruments	$67,895	$134,020	$293,260	3.8% [d]	$5,098	$11,156	$153	0.05%	1.4%
394	Toys and sporting goods	$452,655	$1,300,869	$480,380	3.7%	$47,607	$17,580	$169	0.04%	1.0%
395	Office and art supplies	$126,919	$358,110	$456,773	3.8% [d]	$13,623	$17,377	$160	0.04%	0.9%
396	Costume jewelry & notions	$94,481	$379,044	$418,833	3.8% [d]	$14,420	$15,933	$108	0.03%	0.7%
399	Misc. manufactures	$1,109,935	$3,120,612	$438,288	4.1%	$127,009	$17,838	$157	0.04%	0.9%
411	Local & suburban trans.	$2,426,421	$1,468,804	$221,372	4.4%	$64,611	$9,738	$335	0.15%	3.4%
412	Taxicabs	$323,349	$504,966	$167,651	4.5% [d]	$22,763	$7,557	$108	0.06%	1.4%
413	Intercty & rural bus trans.	$94,298	$74,381	$371,905	5.4%	$3,998	$19,990	$309	0.08%	1.5%
414	Bus charter service	$244,373	$323,685	$348,048	4.6%	$14,876	$15,995	$246	0.07%	1.5%
415	School buses	$479,939	$363,700	$155,627	4.6%	$16,548	$7,081	$187	0.12%	2.6%
417	Bus terminals	$17,483	$9,269	$193,104	4.5% [d]	$418	$8,705	$336	0.17%	3.9%
421	Trking & Courier Service	$20,687,131	$37,505,480	$401,463	3.4%	$1,289,664	$13,805	$205	0.05%	1.5%
422	Pub. warehousing & storage	$3,678,086	$3,179,502	$414,754	10.7%	$338,904	$44,209	$359	0.09%	0.8%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	For all very small firms: Annualized Costs per Firm	For all very small firms: Annualized Costs as a Percent of Revenues	For all very small firms: Annualized Costs as a Percent of Profits
423	Trucking terminal fac.	$23,495	$10,378	$172,967 [b]	3.9% [d]	$406	$6,769	$331	0.19%	4.9%
430	U.S. Postal Service	na	na	na	na	na	na	na	na	na
451	Air trans., scheduled	$2,442,252	$1,380,678	$1,100,142	3.6%	$49,121	$39,140	$606	0.06%	1.5%
452	Air trans., nonsched.	$239,708	$957,365	$725,277	5.3%	$50,740	$38,440	$155	0.02%	0.4%
458	Airports and services	$709,169	$1,185,610	$428,482	3.8%	$45,350	$16,389	$225	0.05%	1.4%
461	Pipelines, excpt natural gas	$411,829	$291,113	$8,821,606	6.5% [d]	$19,061	$577,617	$531	0.01%	0.1%
472	Pass. trans. arrangements	$2,159,216	$5,196,650	$202,173	2.4%	$126,169	$4,909	$70	0.03%	1.4%
473	Freight trans. arrangements	$3,426,174	$4,928,082	$455,124	3.9%	$189,731	$17,522	$265	0.06%	1.5%
474	Rental of railroad cars	$14,353	$227,179	$3,112,041	3.4% [d]	$7,704	$105,530	$145	0.00%	0.1%
478	Misc. trans. services	$735,923	$531,429	$299,228	5.4%	$28,772	$16,200	$347	0.12%	2.1%
481	Telephone communication	$2,028,328	$4,811,628	$857,841	5.9%	$285,528	$50,905	$102	0.01%	0.2%
482	Telegrph & other comm.	$28,505	$341,300	$937,637	5.6% [f]	$19,042	$52,312	$72	0.01%	0.1%
483	Radio & TV broadcasting	$466,711	$1,840,020	$338,053	6.6%	$121,494	$22,321	$80	0.02%	0.4%
484	Cable & othr pay TV service	$367,547	$2,117,829	$1,249,457	2.7%	$57,711	$34,048	$118	0.01%	0.3%
489	Communication serv., n.e.c.	$55,553	$948,974	$781,049	6.1%	$57,887	$47,644	$44	0.01%	0.1%
491	Electric services	$528,214	$1,430,379	$2,639,076	12.5%	$178,321	$329,005	$163	0.01%	0.0%
492	Gas product. & distribution	$484,595	$3,377,499	$6,313,082	7.9%	$266,183	$497,538	$185	0.00%	0.0%
493	Comb. utility services	$110,701	$306,134	$1,749,337	10.4% [d]	$31,761	$181,489	$127	0.01%	0.1%
494	Water supply	$374,055	$1,039,660	$313,245	12.2%	$127,098	$38,294	$107	0.03%	0.3%
495	Sanitary services	$839,808	$2,451,869	$582,253	6.2%	$153,232	$36,389	$167	0.03%	0.5%
496	Steam & air-cond. supplies	$6,120	$50,218	$1,394,944	10.4% [d]	$5,210	$144,722	$125	0.01%	0.1%
497	Irrigation systems	$26,389	$71,818	$207,566	10.4% [d]	$7,451	$21,534	$74	0.04%	0.3%
501	Motor vehicles	$11,025,830	$57,725,483	$1,992,802	2.2%	$1,264,150	$43,641	$284	0.01%	0.7%
502	Furn. & homefurnishings	$3,688,917	$25,565,841	$1,970,696	2.3%	$583,962	$45,014	$257	0.01%	0.6%
503	Lumber & construct. mat.	$8,018,718	$36,044,519	$2,340,857	2.3%	$829,644	$53,880	$405	0.02%	0.8%
504	Prof. & commercial equip.	$9,245,141	$58,977,265	$1,604,780	2.7%	$1,610,147	$43,812	$212	0.01%	0.5%
505	Met. & minerals, excpt pet.	$2,948,811	$49,134,340	$6,790,263	2.6%	$1,269,268	$175,410	$321	0.00%	0.2%
506	Electrical goods	$7,589,494	$88,314,579	$3,500,935	2.5%	$2,214,586	$87,790	$219	0.01%	0.2%
507	Hardware supplies	$8,197,408	$32,741,423	$2,052,239	2.5%	$823,457	$51,614	$366	0.02%	0.7%
508	Mach., equipt, & supplies	$20,206,586	$101,937,718	$1,946,454	2.9%	$2,940,703	$56,151	$309	0.02%	0.5%
509	Misc. durable goods	$6,717,152	$64,760,858	$1,894,867	3.0% [e]	$1,925,322	$56,334	$187	0.01%	0.3%
511	Paper and paper products	$2,572,080	$32,127,109	$2,773,883	1.9%	$620,631	$53,586	$176	0.01%	0.3%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	For all very small firms: Annualized Costs per Firm	For all very small firms: Annualized Costs as a Percent of Revenues	For all very small firms: Annualized Costs as a Percent of Profits
512	Drugs, propriet., & sundries	$1,342,622	$11,908,099	$2,473,125	3.6% [e]	$425,715	$88,414	$231	0.01%	0.3%
513	Apparel and notions	$3,399,139	$44,192,876	$2,456,798	2.5%	$1,095,284	$60,890	$176	0.01%	0.3%
514	Groceries & related products	$10,050,562	$106,043,754	$3,526,680	1.8%	$1,874,721	$62,347	$296	0.01%	0.5%
515	Farm-prod. raw materials	$1,474,524	$41,823,552	$6,961,310	28.3%	$11,847,252	$1,971,913	$166	0.00%	0.0%
516	Chemicals & allied prods	$3,114,523	$37,105,160	$3,958,306	3.1%	$1,144,128	$122,053	$240	0.01%	0.2%
517	Petrol. & petrol. prods	$2,978,006	$65,994,760	$10,268,362	1.3%	$841,994	$131,009	$275	0.00%	0.2%
518	Beer, wine, & dist. bev.	$1,430,477	$8,974,820	$3,642,378	3.5%	$315,565	$128,070	$464	0.01%	0.4%
519	Misc. nondurable goods	$9,161,482	$60,033,260	$1,484,686	2.3%	$1,387,176	$34,306	$188	0.01%	0.5%
521	Lumber & other blding mat.	$7,775,768	$15,866,247	$1,091,965	2.3%	$364,924	$25,115	$419	0.04%	1.7%
523	Paint, glass, wallpaper strs	$2,732,262	$3,282,009	$610,493	2.3%	$73,845	$13,736	$295	0.05%	2.2%
525	Hardware stores	$3,167,507	$5,911,976	$523,415	2.2%	$127,107	$11,253	$249	0.05%	2.2%
526	Retail nurseries and gardens	$2,876,208	$4,981,655	$528,614	2.5% [e]	$122,051	$12,951	$279	0.05%	2.2%
527	Mobile home dealers	$2,106,161	$5,612,243	$1,694,518	3.2%	$180,995	$54,648	$492	0.03%	0.9%
531	Department stores	$17,504	$140,547	$1,171,225	2.8%	$3,935	$32,794	$52	0.00%	0.2%
533	Variety stores	$3,699,518	$1,203,688	$330,502	3.1%	$37,314	$10,246	$386	0.12%	3.8%
539	Misc. gen. merchandise strs.	$2,060,676	$3,202,753	$486,889	2.2%	$70,461	$10,712	$186	0.04%	1.7%
541	Grocery stores	$19,891,309	$43,671,398	$571,428	1.4%	$589,564	$7,714	$203	0.04%	2.6%
542	Meat and fish markets	$1,348,495	$3,818,531	$540,486	2.5%	$95,463	$13,512	$183	0.03%	1.4%
543	Fruit & vegetable markets	$358,992	$1,414,504	$472,288	1.4% [d]	$19,955	$6,663	$116	0.02%	1.7%
544	Candy, nut, & confctnry strs	$698,582	$672,831	$241,504	4.1%	$27,418	$9,841	$159	0.07%	1.6%
545	Dairy products stores	$321,747	$430,018	$290,749	1.4% [d]	$6,067	$4,102	$133	0.05%	3.2%
546	Retail bakeries	$3,337,520	$3,235,280	$212,903	3.2%	$103,529	$6,813	$183	0.09%	2.7%
549	Misc. food stores	$1,200,980	$2,613,544	$370,138	2.4%	$62,072	$8,791	$129	0.03%	1.5%
551	New and used car dealers	$3,430,605	$29,272,772	$3,563,332	1.2% [e]	$358,591	$43,651	$393	0.01%	0.9%
552	Used car dealers	$1,456,428	$19,626,194	$936,141	2.5%	$480,842	$22,935	$68	0.01%	0.3%
553	Auto & home supply stores	$13,501,547	$14,670,042	$570,286	2.3%	$333,743	$12,974	$340	0.06%	2.6%
554	Gas service stations	$17,552,017	$65,121,661	$1,271,312	1.6%	$1,041,947	$20,341	$198	0.02%	1.0%
555	Boat dealers	$1,485,453	$4,874,107	$1,125,660	2.0%	$95,045	$21,950	$315	0.03%	1.4%
556	Rec. vehicle dealers	$1,009,049	$3,776,117	$1,564,906	2.1%	$77,410	$32,081	$394	0.03%	1.2%
557	Motorcycle dealers	$313,036	$4,274,776	$1,271,498	2.8%	$119,694	$35,602	$91	0.01%	0.3%
559	Auto dealers, n.e.c.	$88,967	$917,486	$786,192	2.6% [e]	$23,855	$20,441	$75	0.01%	0.4%
561	Men's & boys' clothing strs	$1,500,392	$3,208,794	$552,003	1.4%	$44,121	$7,590	$120	0.02%	1.6%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	For all very small firms: Annualized Costs per Firm	For all very small firms: Annualized Costs as a Percent of Revenues	For all very small firms: Annualized Costs as a Percent of Profits
562	Women's clothing stores	$4,326,533	$5,967,076	$375,642	1.1%	$65,638	$4,132	$119	0.03%	2.9%
563	Wm's access.& specialty strs	$835,970	$1,265,901	$327,784	1.8% [d]	$23,377	$6,053	$104	0.03%	1.7%
564	Chldrn's & infants' wear strs	$569,139	$893,055	$303,244	1.8% [d]	$16,492	$5,600	$129	0.04%	2.3%
565	Family clothing stores	$3,263,269	$3,250,394	$483,690	2.2%	$69,883	$10,399	$231	0.05%	2.2%
566	Shoe stores	$4,593,305	$3,657,301	$519,872	2.4%	$88,690	$12,607	$165	0.03%	1.3%
569	Misc. apparel stores	$705,055	$2,400,039	$332,139	2.0%	$48,001	$6,643	$75	0.02%	1.1%
571	Furnitre & homefurnishng str	$18,078,465	$28,487,276	$601,937	2.4%	$696,648	$14,720	$303	0.05%	2.1%
572	Household appliance strs	$2,556,580	$5,306,112	$625,647	2.2%	$118,061	$13,921	$278	0.04%	2.0%
573	Radio, TV, & comptr strs	$6,065,913	$16,573,752	$720,128	2.1%	$351,306	$15,264	$172	0.02%	1.1%
581	Eating & drinking places	$46,841,266	$62,342,602	$213,216	3.0%	$1,869,288	$6,393	$138	0.06%	2.2%
591	Drug stores	$7,198,992	$20,363,293	$945,196	2.2%	$442,902	$20,558	$222	0.02%	1.1%
592	Liquor stores	$1,530,053	$14,915,701	$599,337	1.6%	$234,922	$9,440	$55	0.01%	0.6%
593	Used merchandise stores	$3,247,956	$4,225,407	$228,524	4.8%	$203,876	$11,026	$145	0.06%	1.3%
594	Misc. shopping goods strs.	$18,553,068	$32,665,888	$370,009	2.6%	$862,380	$9,768	$156	0.04%	1.6%
596	Nonstore retailers	$5,519,292	$12,225,645	$506,805	2.5%	$304,134	$12,608	$207	0.04%	1.6%
598	Fuel dealers	$3,034,140	$6,904,540	$1,030,682	1.8%	$126,751	$18,921	$295	0.03%	1.6%
599	Retail stores, n.e.c.	$9,772,210	$23,268,601	$314,785	3.2%	$750,317	$10,151	$109	0.03%	1.1%
601	Central res. depository	$7,237	$126,998	$10,583,167	10.8% [d]	$13,716	$1,142,982	$233	0.00%	0.0%
602	Commercial banks	$7,249,911	$6,215,272	$2,296,000	10.8% [d]	$671,249	$247,968	$153	0.01%	0.1%
603	Savings institutions	$1,698,251	$2,075,332	$3,336,547	10.8% [d]	$224,136	$360,347	$156	0.00%	0.0%
606	Credit unions	$1,290,647	$6,290,272	$755,044	10.8% [d]	$679,349	$81,545	$105	0.01%	0.1%
608	Foreign banking	$39,639	$1,241,706	$12,173,588	10.8% [d]	$134,104	$1,314,748	$127	0.00%	0.0%
609	Banking-related functions	$513,323	$1,368,201	$459,282	10.8% [d]	$147,766	$49,602	$101	0.02%	0.2%
611	Federal credit agencies	$108,937	$127,485	$1,722,770	10.8%	$13,768	$186,059	$97	0.01%	0.1%
614	Personal cred. institutions	$1,428,038	$3,486,159	$856,550	15.5% [d]	$539,193	$132,480	$83	0.01%	0.1%
615	Business cred. institutions	$460,695	$4,947,066	$1,814,771	17.1% [d]	$844,648	$309,849	$101	0.01%	0.0%
616	Mortgage bankers & brokers	$1,886,455	$5,061,228	$397,146	11.7%	$589,838	$46,284	$96	0.02%	0.2%
621	Security brokers & dealers	$1,987,067	$6,612,505	$842,572	12.8%	$844,196	$107,568	$95	0.01%	0.1%
622	Commodity contracts brokers	$91,769	$881,352	$640,983	13.3%	$117,356	$85,350	$62	0.01%	0.1%
623	Security & commod. exchan	$8,867	$32,734	$545,567	13.3%	$4,359	$72,645	$100	0.02%	0.1%
628	Security & commod. services	$1,380,144	$7,492,941	$466,966	15.3% [d]	$1,148,077	$71,549	$81	0.02%	0.1%
631	Life insurance	$1,184,923	$2,777,904	$3,346,872	6.8% [d]	$189,546	$228,369	$156	0.00%	0.1%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

								For all very small firms		
SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
632	Medical & health insur.	$290,570	$2,824,245	$4,637,512	3.6%	$101,867	$167,270	$142	0.00%	0.1%
633	Fire, marine, & caslty ins.	$1,746,618	$2,862,923	$1,879,792	9.1% [d]	$259,095	$170,121	$104	0.01%	0.1%
635	Surety insurance	$54,423	$425,650	$2,086,520	6.8%	$29,044	$142,370	$113	0.01%	0.1%
636	Title insurance	$275,458	$212,137	$380,856	4.6%	$9,652	$17,329	$134	0.04%	0.8%
637	Pension and health funds	$238,320	$849,385	$391,602	6.8% [f]	$57,956	$26,720	$101	0.03%	0.4%
639	Ins. carriers, n.e.c.	$26,373	$175,292	$872,100	6.8%	$11,961	$59,506	$112	0.01%	0.2%
641	Insurance agents	$9,653,557	$31,072,071	$276,764	6.8% [d]	$2,120,669	$18,889	$80	0.03%	0.4%
651	Real estate operators	$9,851,875	$51,322,198	$563,015	14.1% [d]	$7,221,217	$79,218	$103	0.02%	0.1%
653	RE agents and managers	$10,082,095	$37,861,382	$351,790	13.2%	$5,007,168	$46,524	$86	0.02%	0.2%
654	Title abstract offices	$435,298	$1,252,913	$306,711	13.3% [e]	$166,756	$40,821	$92	0.03%	0.2%
655	Subdividers & developrs	$1,783,492	$7,676,583	$465,756	10.6%	$814,400	$49,411	$103	0.02%	0.2%
671	Holding offices	$848,720	$5,148,112	$983,215	25.4%	$1,306,839	$249,587	$103	0.01%	0.0%
672	Investment offices	$66,206	$1,718,384	$2,504,933	20.4%	$351,041	$511,722	$79	0.00%	0.0%
673	Trusts	$690,137	$5,079,834	$640,746	24.3%	$1,234,273	$155,685	$84	0.01%	0.1%
679	Miscellaneous investing	$682,275	$9,524,886	$1,309,443	21.5%	$2,051,829	$282,077	$87	0.01%	0.0%
701	Hotels and motels	$6,349,696	$8,638,183	$294,537	7.0%	$600,354	$20,470	$196	0.07%	1.0%
702	Rooming & boarding houses	$93,722	$259,463	$176,505	7.0%	$18,060	$12,286	$61	0.03%	0.5%
703	Camps and rec. vehicle parks	$245,366	$1,690,717	$263,845	7.3%	$124,022	$19,354	$35	0.01%	0.2%
704	Membership-basis org. hotels	$140,908	$435,978	$193,338	7.0% [d]	$30,346	$13,457	$60	0.03%	0.4%
721	Laundry & garment srvices	$10,379,942	$7,783,309	$166,584	5.9%	$461,638	$9,880	$203	0.12%	2.1%
722	Photo studios, portrait	$944,924	$1,699,071	$202,656	4.5% [d]	$76,458	$9,120	$74	0.04%	0.8%
723	Beauty shops	$4,574,096	$7,617,832	$107,510	4.4%	$335,185	$4,730	$58	0.05%	1.2%
724	Barber shops	$544,847	$350,653	$83,509	5.9%	$20,531	$4,889	$124	0.15%	2.5%
725	Shoe repair	$231,171	$209,963	$102,873	5.9%	$12,293	$6,023	$110	0.11%	1.8%
726	Fun. service and crematories	$2,043,782	$5,734,274	$501,686	7.6% [d]	$432,938	$37,877	$149	0.03%	0.4%
729	Misc personal services.	$1,514,670	$3,452,437	$139,088	6.6% [d]	$226,625	$9,130	$53	0.04%	0.6%
731	Advertising	$1,997,716	$8,139,343	$498,612	3.9%	$317,695	$19,462	$115	0.02%	0.6%
732	Credit report.& collection	$739,933	$1,765,296	$358,290	5.4%	$95,898	$19,464	$133	0.04%	0.7%
733	Mailing, reprod, steno., serv	$3,471,741	$10,979,283	$348,261	4.7%	$518,035	$16,432	$109	0.03%	0.7%
734	Services to buildings	$5,573,882	$8,217,682	$143,440	3.5%	$289,477	$5,053	$96	0.07%	1.9%
735	Misc. equipt. rental	$3,752,236	$8,260,418	$557,534	8.8%	$730,600	$49,312	$174	0.03%	0.4%
736	Pers. supply services	$1,952,808	$6,448,228	$373,810	3.3%	$210,360	$12,195	$96	0.03%	0.8%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

								For all very small firms		
SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	Annualized Costs per Firm	Annualized Costs as a Percent of Revenues	Annualized Costs as a Percent of Profits
737	Comptr & data proc. services	$7,872,892	$28,733,221	$406,336	4.9%	$1,419,238	$20,070	$102	0.02%	0.5%
738	Misc. business services	$5,854,472	$21,125,209	$299,780	5.1%	$1,071,552	$15,206	$79	0.03%	0.5%
751	Auto rentals, no drivers	$1,643,649	$3,370,860	$689,902	5.4%	$183,669	$37,591	$181	0.03%	0.5%
752	Automobile parking	$814,540	$743,553	$415,393	4.4%	$32,663	$18,248	$115	0.03%	0.6%
753	Automotive repair shops	$23,317,965	$39,577,660	$305,907	3.9%	$1,527,706	$11,808	$172	0.06%	1.5%
754	Automotive serv., exc repair	$5,311,540	$4,591,217	$221,295	4.4% [d]	$203,735	$9,820	$222	0.10%	2.3%
762	Electrical repair shops	$3,197,976	$4,493,450	$275,689	4.6%	$208,316	$12,781	$181	0.07%	1.4%
763	Watch and jewelry repair	$245,584	$253,189	$158,739	5.4%	$13,763	$8,629	$141	0.09%	1.6%
764	Reupholstery & furn. repair	$791,667	$1,047,917	$152,026	5.4%	$56,963	$8,264	$117	0.08%	1.4%
769	Misc. repair shops	$7,060,400	$11,475,584	$322,574	5.9% [d]	$672,141	$18,894	$194	0.06%	1.0%
781	Motion picture production	$2,358,579	$7,573,063	$563,766	4.7% [d]	$356,693	$26,554	$173	0.03%	0.7%
782	Motion picture dist.	$300,860	$1,562,938	$1,444,490	5.1%	$80,301	$74,216	$248	0.02%	0.3%
783	Motion picture theaters	$1,814,001	$766,131	$363,958	6.3%	$47,941	$22,775	$446	0.12%	2.0%
784	Video tape rental	$5,151,272	$2,635,735	$194,347	5.9% [d]	$154,849	$11,418	$267	0.14%	2.3%
791	Dance studios & schools	$370,510	$690,662	$124,064	4.3%	$29,561	$5,310	$67	0.05%	1.3%
792	Prducrs, orch., entertainers	$1,442,180	$8,565,302	$554,963	4.6%	$395,214	$25,607	$94	0.02%	0.4%
793	Bowling centers	$678,524	$968,675	$256,399	3.8% [d]	$36,325	$9,615	$173	0.07%	1.8%
794	Commercial sports	$686,037	$2,164,149	$531,863	3.5%	$74,663	$18,349	$168	0.03%	0.9%
799	Misc. recreation services	$7,054,099	$13,195,422	$267,960	4.4%	$586,841	$11,917	$139	0.05%	1.2%
801	Offices of medical doctors	$25,687,876	$87,978,993	$555,426	6.4%	$5,608,661	$35,408	$152	0.03%	0.4%
802	Dentists offices and clinics	$17,853,940	$41,066,668	$377,305	10.5%	$4,291,467	$39,428	$163	0.04%	0.4%
803	Osteopathic physicians	$841,355	$3,467,034	$409,041	13.4% [e]	$463,716	$54,709	$97	0.02%	0.2%
804	Other health practitioners	$11,304,197	$19,394,348	$243,651	7.4%	$1,430,918	$17,977	$139	0.06%	0.8%
805	Nursing & personal care fac.	$2,209,335	$1,432,002	$306,376	4.7%	$67,849	$14,516	$282	0.09%	1.9%
806	Hospitals	$96,197	$504,465	$2,084,566	5.5%	$27,724	$114,563	$227	0.01%	0.2%
807	Med. & dental labs	$1,994,137	$3,958,716	$345,046	7.2%	$284,284	$24,779	$148	0.04%	0.6%
808	Home hlth care services	$1,886,069	$1,879,363	$328,675	3.2%	$59,670	$10,435	$229	0.07%	2.2%
809	Hlth & allied serv., n.e.c.	$3,348,743	$3,836,596	$401,402	6.7%	$257,189	$26,908	$211	0.05%	0.8%
811	Legal services	$14,936,859	$52,803,005	$338,722	17.5%	$9,240,526	$59,276	$94	0.03%	0.2%
821	Elem. & secondary schools	$1,836,323	$2,453,454	$335,676	5.9% [e]	$144,140	$19,721	$197	0.06%	1.0%
822	Colleges & universities	$240,626	$427,806	$422,316	9.1%	$39,093	$38,592	$176	0.04%	0.5%
823	Libraries	$197,636	$234,869	$124,138	8.1%	$19,122	$10,107	$100	0.08%	1.0%

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	For all very small firms: Annualized Costs per Firm	For all very small firms: Annualized Costs as a Percent of Revenues	For all very small firms: Annualized Costs as a Percent of Profits
824	Vocational schools	$566,465	$1,465,565	$274,348	6.3%	$92,511	$17,318	$98	0.04%	0.6%
829	Schools, n.e.c.	$1,280,060	$3,234,624	$240,887	5.5% [d]	$176,287	$13,128	$92	0.04%	0.7%
832	Individual & fam. services	$5,237,355	$5,119,204	$183,873	4.5%	$229,084	$8,228	$147	0.08%	1.8%
833	Job train. & related serv.	$756,472	$915,449	$272,050	3.4%	$31,125	$9,250	$131	0.05%	1.4%
835	Child day care services	$5,381,390	$4,474,833	$112,016	4.7%	$208,080	$5,209	$119	0.11%	2.3%
836	Residential care	$4,793,905	$2,154,658	$169,618	3.4%	$73,797	$5,809	$218	0.13%	3.8%
839	Social services, n.e.c.	$1,419,875	$4,717,297	$468,265	5.3%	$250,017	$24,818	$108	0.02%	0.4%
841	Museums & art galleries	$441,602	$721,567	$197,203	21.5%	$154,776	$42,300	$114	0.06%	0.3%
842	Bot. & zoolog. gardens	$60,366	$108,760	$268,543	21.5%	$23,329	$57,603	$133	0.05%	0.2%
861	Business associations	$1,470,347	$5,475,973	$386,667	3.9%	$215,388	$15,209	$100	0.03%	0.7%
862	Prof. organizations	$570,382	$2,590,876	$415,871	4.9% [d]	$126,953	$20,378	$89	0.02%	0.4%
863	Labor organizations	$1,483,375	$5,137,494	$297,412	8.6%	$441,824	$25,577	$83	0.03%	0.3%
864	Civic & social assoc.	$3,593,256	$6,936,547	$218,860	4.3%	$294,803	$9,302	$109	0.05%	1.2%
865	Political organizations	$220,666	$697,077	$280,740	7.2%	$50,270	$20,246	$89	0.03%	0.4%
866	Religious organizations	$11,957,336	$26,408,707	$183,752	8.9%	$2,343,773	$16,308	$83	0.05%	0.5%
869	Membership orgs., n.e.c.	$941,229	$1,856,411	$276,540	8.5% [d]	$157,795	$23,506	$119	0.04%	0.5%
871	Eng. and arch. services	$8,996,897	$24,141,771	$372,754	4.6%	$1,114,119	$17,202	$130	0.03%	0.8%
872	Accntng, auditng, & bkeepin	$9,226,542	$18,007,357	$231,427	12.0%	$2,151,879	$27,656	$116	0.05%	0.4%
873	Research & testing services	$2,719,289	$6,238,312	$485,207	4.9%	$306,972	$23,876	$177	0.04%	0.7%
874	Management & pub. relation	$8,615,971	$29,651,372	$360,411	6.3%	$1,855,190	$22,550	$99	0.03%	0.4%
899	Services, n.e.c.	$2,179,090	$4,867,692	$322,791	6.8%	$331,003	$21,950	$136	0.04%	0.6%
Total		**$790,733,223**	**$2,493,192,901**			**$127,230,790**				
Average (weighted)		**$11,989,094**	**$30,050,583**	**$588,144**	**5.9%**	**1,784,293**	**30,014**	**155**	**0.04%**	**1.0%**

Source: Office of Regulatory Analysis.
Revenue data are from U.S. Dept. of Commerce, Bureau of Census. Compliance costs are from Chapter V of this Final Economic Analysis. Profit data are derived from Robert Morris Associates, RMA Annual Statement Studies 1995-1998 (RMA) and U.S. Department of the Treasury, 1995-1997 (IRS). Average profit rates for the period 1995 through 1998 were calculated from a weighted average of profit rates over this period for all 4-digit industries associated with each 3-digit SIC classification. Revenues were used as weights in this calculation.

Table VIII-5 Estimated Economic Impact of the Ergonomics Program Standard on All Very Small Firms *

SIC	Industry	Annualized Compliance Costs for All Very Small Establishments	Revenues for Very Small Firms ($1,000s)	Average Revenues for Very Small Firms ($)	Profits as a Percentage of Revenues [c]	Profits ($1,000s)	Average Profits per firm ($)	For all very small firms: Annualized Costs per Firm	For all very small firms: Annualized Costs as a Percent of Revenues	For all very small firms: Annualized Costs as a Percent of Profits

* "Very small firm" refers to firms with 1-19 employees.

[a] Excludes SIC 3731 (not in the scope of proposed standard)

[b] Revenue data was wholely or partially suppressed by the Census Bureau for the 1-19 employee entity size category. Any projected economic impacts are therefore overestimated for these industries. Where estimated costs as a percent of profits would be in excess of 20 percent, revenues and profits are reported as "na", because the high impact is at least partially the direct result of revenue data supr

[c] Profit rates, except where noted, are derived from Robert Morris Associates ' "RMA Studies."

[d] Profit data not available for all 4-digit industries in this classification; profit rates interpolated from a combination of RMA and IRS profit data.

[e] Based on a combination of RMA and IRS profit data.

[f] Based on IRS profit data.

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H. Summary of the Final Regulatory Flexibility Analysis

The Regulatory Flexibility Act, as amended in 1996, requires that a Final Regulatory Flexibility Analysis (FRFA) contain the following elements: [3]

(1) a succinct statement of the need for, and objectives of, the rule;

(2) a summary of significant issues raised by public comments on the Initial Regulatory Flexibility Analysis (IRFA), a summary of the assessment of the Agency of the issues, and a statement of any changes made in the proposal as a result of the comments;

(3) a description and estimate of the number of small entities affected by the final standard, where possible;

(4) a description of the reporting, recordkeeping, and other compliance requirements of the rule, including an estimate of the classes of small entities which will be subject to the requirements, and the type of professional skills necessary for the preparation of the report or record; and

(5) a description of the steps the Agency has taken to minimize the significant economic impact on small entities consistent with the stated objectives of the applicable statutes, including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each one of the other significant alternatives to the rule considered by the Agency which affect the impact of the small entities was rejected.

In addition, a Final Regulatory Flexibility Analysis must contain a description of any significant alternatives to the proposed rule that accomplish the stated objectives of the applicable statute (in this case the OSH Act) and that minimize any significant economic impact of the proposed rule on small entities. This section summarizes OSHA's Final Regulatory Flexibility Analysis. The full analysis, including responses to comments on the IRFA and a discussion of alternatives, is provided as part of the Final Economic and Regulatory Flexibility Analysis, which is Ex. 900 in the Docket.

1. Description of the Reasons for Agency Action. OSHA is issuing a final Ergonomics Program Standard to address the significant risk of employee exposure to ergonomic risk factors in general industry workplaces. Exposure to ergonomic risk factors on the job leads to MSDs of the upper extremities, back, and lower extremities. Every year, nearly 600,000 MSDs that are serious enough to cause time off work are reported to the Bureau of Labor Statistics by employers, and evidence suggests that an even larger number of non-lost worktime MSDs occur every year. The purpose of this standard is to reduce the number and severity of MSDs caused by exposure to risk factors in the workplace.

2. Significant issues raised by public comments on the Initial Regulatory Flexibility Analysis (IRFA), an assessment of the issues, and changes made in the proposal as a result of the comments. Relatively few commenters provided comment on the Initial Regulatory Flexibility Analysis. However commenters did raise many issues relevant to the regulatory flexibility analysis. Some of the principal issues raised by public comments that have special relevance to regulatory flexibility analysis, and OSHA's responses to them, are summarized in the remainder of this section.

Many commenters referred to an estimate attributed to SBA that the costs of complying with the proposal would be 2.5 to 15 times higher than the Agency's estimate (see, *e.g.,* Tr. pp. 7767–7768, pp. 5730–5731, pp. 16005–16006, p. 9975, pp. 15668–15669, 30–2047. 30–3811, 30–2056, 30–238, 31–326, 31–326, 30–2058). While OSHA does not agree with that estimate, OSHA has revised the rule in a variety of ways to make it less costly to small businesses. The introduction of a two part action trigger will have the effect of significantly decreasing the number of jobs small businesses will need to address through a full ergonomics program or a quick fix. OSHA has also increased its estimates of many of the unit costs for activities required in response to comments from businesses of all sizes and SBA.

Many small businesses were concerned about would be the necessity of hiring consultants or ergonomic experts (which the standard does not require) (see, *e.g.,* Exs. 30–2993, Tr. p. 15586, Exs. 30–3849, 30–3166, 30–4334, 30–3167, 30–2993, Tr. pp. 14934, 30–3231, Tr. pp. 16935–16936). OSHA has increased its estimate of the time that managers will need to understand how to implement ergonomics programs, but continues to believe that, with adequate training, ergonomic consultants will be needed for only 15 percent of all problem jobs.

Some commenters were concerned about the differing impact of the final standard on large and small employers. ''Smaller businesses unlike large corporations do not maintain positions for health and safety officers * * * many small businesses will be forced to obtain consultations and assistance from an outside firm'' (Tr. pp. 9195–9196). Or that small businesses ''do not have means to hire'' experts such as ergonomists, engineers, and doctors (Tr. pp. 9258–9259), a statement that was repeated by many commenters from small businesses. Many small businesses also stated that the complexity of the standard and specialized skills necessary for job hazard analysis or job controls would make compliance difficult. ''The vast majority of small businesses * * * lack the safety and health expertise necessary to interpret the complex standard'' (Ex. 30–4843). Other commenters found the standard and ergonomics too technical, too complex, or beyond their abilities (*e.g.,* Exs. 30–4334, 30–1545, Tr. pp. 12770–12771, 15564–15566). OSHA agrees that the standard may have greater impacts on small businesses than on large businesses. However, as Chapter VII of the final economic analysis demonstrates, the standard is economically feasible even for very small businesses and will reduce significant risk to small entity employees. Furthermore, in the long run, the standard will lead to significant reductions in the costs of workers' compensation and other injury related costs for many small employers.

In terms of the regulatory approach of the proposal, some small business commenters urged the Agency to provide a specification type of standard. ''Small businesses * * * often cannot deal with that type of flexibility [referring to controlling hazards] and so prefer certainty'' (Tr. pp. 6202–6206). ''What OSHA failed to do in the proposed standard is give the specific steps that a small business owner must take to prevent MSDs. The proposed standard only gives small businesses a process for how they should develop their own solutions to the MSD problem'' (Ex. 30–1897). ''Small businesses prefer certainty which rule [sic] unfortunately does not provide'' (Tr. pp. 6202–6206). In developing the final rule, OSHA has tried to retain the flexibility that will reduce costs to many small employers, while adding clarity to many provisions. Particularly the use of the screen as part of the action trigger and the optional safe harbors for determining compliance should significantly simplify compliance for the small employer.

[3] The Regulatory Flexibility Act states that a Regulatory Flexibility Analysis need not contain all of the above elements *in toto* if these elements are presented elsewhere in the documentation and analysis of the rule. The Regulatory Flexibility Analysis should, however, summarize where these elements can be found elsewhere in the rulemaking record.

3. An estimate of the number of small entities affected by the final standard. OSHA estimates that there are 4.75 million small establishments in general industry affected by the rule. The final standard covers an estimated 4.2 million very small entities (*i.e.,* those employing fewer than 20 employees).

4. Reporting, recordkeeping, and other compliance requirements of the rule, including an estimate of the classes of small entities which will be subject to the requirements and the type of professional skills necessary for the preparation of the report or record. Table VII–6 summarizes the compliance requirements of the rule, which types of small entities they apply to, the expected burden requirements, and the types of professional skills needed.

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Table VIII-6. Estimates of Mangers' and Employees' Time To Comply with Various Provisions of the Final Rule and Comparisons with the Estimates of Time Needed for these Activities for the Proposed Rule

Provision		When Required		Hours or Costs Involved		Level of Staff or Expertise Required (Both proposed and final rules)
Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	
Costs to determine if establishment is within the scope of the standard, and if so, whether it can qualify for grandfather status	Costs to determine if establishment is within the scope of the standard, and if so, whether it can qualify for grandfather status	Initially for all establishments in general industry		2 hours	1 hour	Manager
Cost to familiarize employer with the standard's initial requirements, determine hazard awareness information needed, set up reporting system, post information, and set up report response system	Cost to implement proposed hazard information and reporting requirement (designating responsible persons, providing resources, etc.)	All establishments in general industry*	All general industry establishments with basic programs (i.e all with manual handling or manufacturing jobs); otherwise, only if MSD occurs*	4 hours	3 hours	Manager

Table VIII-6. Estimates of Mangers' and Employees' Time To Comply with Various Provisions of the Final Rule and Comparisons with the Estimates of Time Needed for these Activities for the Proposed Rule

Provision		When Required		Hours or Costs Involved		Level of Staff or Expertise Required (Both proposed and final rules)
Final Rule	**Corresponding Proposed Provision**	**Final Rule**	**Corresponding Proposed Provision**	**Final Rule**	**Corresponding Proposed Provision**	
Cost to provide employee information (initial requirement)		All establishments in general industry*	Establishments with basic programs (i.e., all with manual handling or manufacturing jobs); otherwise, only if MSD occurs	1 hour per employee plus 1 hour managerial time	0.5 hour per employee plus 0.5 hour managerial time	Manager

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Provision		When Required		Hours or Costs Involved		Level of Staff or Expertise Required (Both proposed and final rules)
Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	
Cost to investigate whether an MSD or persistent signs or symptoms are covered by the standard and determine whether MSD incidents occurred in job that meets the screen	Cost to investigate whether an MSD or persistent symptoms are covered by the standard for all establishments with manual handling and manufacturing jobs; cost to investigate whether an MSD is covered by the standard for all general industry establishments)	All establishments in general industry where there is a report of an MSD or persistent signs and symptoms	All establishments where persistent symptoms or an MSD occurs in manufacturing or manual handling establishments; otherwise, only where an MSD occurs	0.25 hour of managerial time and 0.25 hour of employee time to process each MSD report; 1.75 hours of managerial time to analyze whether MSD is an MSD incident and apply the screen to the job	0.25 hour of managerial time and 0.25 hour of employee time to process each MSD report	Manager

Table VIII-6. Estimates of Mangers' and Employees' Time To Comply with Various Provisions of the Final Rule and Comparisons with the Estimates of Time Needed for these Activities for the Proposed Rule

Provision		When Required		Hours or Costs Involved		Level of Staff or Expertise Required (Both proposed and final rules)
Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	
Cost to designate responsible manager, review reporting polices, provide managerial training and information in establishments with full program or using quick fix (standard does not require managerial training for quick fix, but analysis assumes this activity necessary for costing purposes)		All establishments with jobs meeting two-part action trigger *	If persistent symptoms or an MSD occurs in manufacturing or manual handling establishments; otherwise, only where an MSD occurs*	24 hours of managerial time	16 hours of managerial time	Manager
Cost to train employees in establishments with full programs		All employees in jobs that have met the two-part action trigger*	All employees in problem jobs in establishments*	3 hours of employee time per affected employee, 3 hours of managerial time per problem job to provide training; 25 percent of employers able to use quick fix option and these do not need to conduct employee training.	1 hour of employee time per affected employee, 2 hours of managerial time per problem job to provide training; 25 percent of employers able to use quick fix option and these do not need to conduct employee training.	Manager with training required for the full program

Table VIII-6. Estimates of Mangers' and Employees' Time To Comply with Various Provisions of the Final Rule and Comparisons with the Estimates of Time Needed for these Activities for the Proposed Rule

Provision		When Required		Hours or Costs Involved		Level of Staff or Expertise Required (Both proposed and final rules)
Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	
Cost of job hazard analysis (standard does not require job hazard analysis for quick fix, but analysis assumes job hazard analysis necessary for costing purposes)		All establishments with jobs that have met the two part action trigger*	All establishments with problem jobs*	1 hour of managerial time plus 1 hour employee time per problem job		Manager with full program training
Cost to evaluate and implement job controls (standard does not require full evaluation of job controls for quick fix, but analysis assumes evaluation necessary for costing purposes)		All establishments with jobs that have met the screen and been determined to have MSD hazards*	All establishments with problem jobs*	2-16 hours of employee and 2-32 hours of managerial time, depending on problem job; in 15 percent of cases, $2,000 for consulting ergonomist's time is assumed to be required		In 85 percent of cases, manager with full program training; in 15 percent of cases, consultant ergonomist.

Table VIII-6. Estimates of Mangers' and Employees' Time To Comply with Various Provisions of the Final Rule and Comparisons with the Estimates of Time Needed for these Activities for the Proposed Rule

Provision		When Required		Hours or Costs Involved		Level of Staff or Expertise Required (Both proposed and final rules)
Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	
Cost to administer MSD management (without WRP costs)		All establishments with jobs that have met the action trigger*	All establishments with problem jobs*	1 hour of managerial time; 2 hr worker's time; $130 for HCP's time for the 15.5% of MSDs where no HCP is currently provided; 20% of all cases involving a second opinion; 5% of all cases involving a third opinion	1 hour of managerial time; 2 hr worker's time per MSD	Manager with full program training, health care professional, or safety and health professional
Cost to do recordkeeping		All establishments with 11 or more employees must keep records if there is an employee report of an MSD or MSD signs and symptoms*	All establishments with 10 or more employees must keep records if there is an employee report of an MSD or MSD signs and symptoms*	0.5 hour of supervisory time per MSD	0.25 hour of supervisory time per MSD	Supervisor

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Provision		When Required		Hours or Costs Involved		Level of Staff or Expertise Required (Both proposed and final rules)
Final Rule	**Corresponding Proposed Provision**	**Final Rule**	**Corresponding Proposed Provision**	**Final Rule**	**Corresponding Proposed Provision**	
Cost to conduct program evaluation		All establishments with full programs*		4 hours of managerial time in the three years following discover of job meeting two part action trigger. For 25 percent of problem jobs able to use quick fix option, no program evaluation is conducted.		Manager with full program training
Cost to implement job controls--engineering, work practice, or administrative controls		All establishments with jobs that meet the action trigger and are determined to have MSD hazards*	All establishments with problem jobs*	Costs per job intervention per affected employee vary by industry and occupational group and are presented in detail in Chapter V of Final Economic Analysis (affected employees include the employee incurring the MSD incident in a job meeting the screen and found to have MSD hazards and all other employees in the establishment with the same job)	Costs per job intervention per affected employee vary by industry and occupational groups and are presented in detail in Tables V-9 to V-13 of Preliminary Economic Analysis (affected employees include the employee incurring the MSD and all other employees in the establishment with the same job)	Covered under costs calculated for evaluating and implementing controls (above)

Table VIII-6. Estimates of Mangers' and Employees' Time To Comply with Various Provisions of the Final Rule and Comparisons with the Estimates of Time Needed for these Activities for the Proposed Rule

Provision		When Required		Hours or Costs Involved		Level of Staff or Expertise Required (Both proposed and final rules)
Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	Final Rule	Corresponding Proposed Provision	
Cost to provide work restriction protection		All establishments with jobs meeting the two-part action trigger (but MSD management costs only for incurred injured employees)*	All establishments with problem jobs*	$944 per MSD for work restriction protection, plus $104 per case (11%) for administrative costs to employer	$923 per MSD	Manager
Employee involvement, in addition to employee involvement as part of training, job hazard analysis, and implementing job controls		All establishments with jobs that meet the action trigger, where quick fix option is not used *	Establishments with basic programs: i.e. all with manual handling or manufacturing jobs; otherwise, only if MSD occurs*	4 hours initially when full program begins, 2 hours annually, 2 hours for program evaluation	Not costed	Nonsupervisory employee(s)

*Except for costs to review the standard to determine whether an existing program qualifies for grandfather status, OSHA's analysis assumes that programs are grandfathered in will not incur costs to implement an ergonomics program (since they already have programs), except costs for work restriction protection and multiple HCP review.

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5. Steps the Agency has taken to minimize the significant economic impact on small entities. The final standard contains many elements that will reduce burden on small entities as compared with the proposal. The scope of the standard is simplified. All employers must provide basic information to employees, and there are no special obligations for employers with employees engaged in manufacturing or manual handling operations. Employers will need less time and effort to determine how they are affected by the scope of the rule. In the appendices to the standard, OSHA has provided material that employers can use to meet this requirement, further reducing the burden of the rule. The Agency has also kept an MSD trigger mechanism, and has added a screen. Employers do not need to do anything beyond provide information to employees unless an MSD incident in a job that meets the screen. The addition of the screen serves both to simplify decisionmaking for small employers and to target the rule toward high risk jobs. For employees in jobs meeting the action trigger, employers must provide a quick fix or initiate an ergonomics program. In addition, the employer need not control the job unless MSD hazards are found during the job hazard analysis. Employers may meet their job hazard analysis and control obligations in any one of a variety of ways. The addition of clearer compliance endpoints will reduce employer uncertainty about whether they are in compliance with the rule. Finally, an employer can cease having a program at any time the risks in the job are lowered so that the job no longer meets the screen.

Establishments with fewer than 11 employees do not have to keep records. Where a job hazard analysis or job controls are necessary, employers do not have to hire a professional ergonomic consultant. The Agency will also supply compliance guides for small businesses and a Web-based expert system to guide employers through the applicability of the final standard. The Agency has provided flexibility in choosing controls to reduce MSD hazards, including administrative controls along with engineering and work-practice controls. Finally, the Agency is permitting existing ergonomic programs to be grandfathered and considered in compliance with the standard as long as the existing program meets the requirements in paragraph (c).

The principal reasons that the Agency has made its revisions for the final standard are to make the final standard less costly, more cost-effective, and still achieve the goal of employee protection. These revisions will help all employers, including small employers.

Alternatives to the Proposed Standard

In the Final Regulatory Flexibility Analysis, OSHA considered alternatives with respect to voluntary action, alternative scope provisions, alternative trigger provisions, alternative work restriction protection provisions and other approaches to the rule making such as exempting small or low hazard employers. SBA's Office of Advocacy (Ex. 601–X–1) urged OSHA to consider exempting low hazard industries, and exempting small firms from WRP. OSHA believes that the new two part action trigger is a superior means of focusing the rule's obligation on high hazard work situations, while maintaining employee protection. The action trigger serves to assure that employers do not need to try to fix low hazard jobs. Further, this approach does this in a way that assures that even small firms in high hazard industries will not need to fix their low hazard jobs, while workers in the occasional high hazard job in a low hazard industry receive the protection they need. Exempting small businesses from WRP would remove needed protections for employees in small businesses. The Agency's analysis found that those alternatives that significantly alleviated the impact on small businesses more than OSHA's final standard did not provide adequate protection to worker health and safety. Many of the alternatives to specific provisions, such as WRP, are also discussed in the Preamble in the sections describing these provisions.

IX. Unfunded Mandates

OSHA reviewed the final ergonomics program standard in accordance with the Unfunded Mandates Reform Act of 1995 (UMRA) (2 U.S.C. 1501 et seq.). As discussed above in the Summary of the Final Economic Analysis (Section VIII of the preamble), OSHA estimates that compliance with the final ergonomics program standard will require the expenditure of approximately $4.0 billion each year by employers in the private sector. Therefore, the final ergonomics program standard establishes a federal private sector mandate and is a significant regulatory action, within the meaning of Section 202 of UMRA (2 U.S.C. 1532). OSHA has included this statement to address the anticipated effects of the final ergonomics program standard pursuant to Section 202.

OSHA standards do not apply to state and local governments, except in states that have voluntarily elected to adopt an OSHA State Plan. Consequently, the final standard does not meet the definition of a ''Federal intergovernmental mandate'' (Section 421(5) of UMRA (2 U.S.C. 658(5)).

This final rule was proposed under Section 6(b) of the OSH Act. The final ergonomic program standard will prevent 4.6 million MSDs over the next 10 years. The final ergonomics program standard will lead to $558 million per year in costs on state, local or tribal governments. OSHA pays 50 percent of State plan costs but does not provide funding for state, local or tribal governments to comply with its rules.

OSHA does not anticipate any disproportionate budgetary effects upon any particular region of the nation or particular state, local, or tribal governments, or urban or rural or other types of communities. Chapters V and VI of the economic analysis provide detailed analyses of the costs and impacts of the final rule on particular segments of the private sector. OSHA has analyzed the economic impacts of the rule on the affected industries and found that compliance costs are, on average, only 0.05 percent of sales, and that few, if any, facility closures or job losses are anticipated in the affected industries. As a result, impacts on the national economy would be too small to be measurable by economic models.

The anticipated benefits and costs of this final standard are addressed in the Summary of the Final Economic Analysis (Section VIII of this preamble), above, and in the Final Economic Analysis (Ex. 900). In addition, pursuant to Section 205 of the UMRA (2 U.S.C. 1535), having considered a reasonable number of alternatives as outlined in this preamble and in the economic analysis (Ex. 900), the Agency has concluded that the final standard is the most cost-effective alternative for implementation of OSHA's statutory objective of substantially reducing or eliminating a significant risk of material impairment. This is discussed at length in the economic analysis (Ex. 900) and in the Summary and Explanation (Section IV of this preamble) for the various provisions of the final ergonomics program standard.

X. Environmental Impact Statement

Pursuant to the National Environmental Policy Act, the Department of Labor has issued regulations to determine when an environmental impact statement is required in a rulemaking proceeding. Section 29 CFR § 11.10(a)(3) states:

> Preparation of an environmental impact statement will always be required for

proposals for promulgation, modification or revocation of health standards which will significantly affect air, water, soil quality, plant or animal life, the use of land and other aspects of the human environment.

In the preamble to the proposed rule, the Agency stated that no environmental impact statement would be required for this rule because it does not meet the criteria set forth in 29 CFR § 11.10(a)(3), as stated above. OSHA received one comment disagreeing with this determination. The commenter (Ex. 500–221) suggested that employer compliance activities associated with the proposed Ergonomics Program Standard would have the potential to cause enormous environmental impacts. The commenter also suggested that the proposed standard would increase the demand for electricity by encouraging workplace automation; increase the consumption of natural resources by encouraging employers to use greater numbers of smaller product containers; and impair air quality by encouraging delivery vehicles to remain at idle while employees manually move smaller loads per trip. Finally, the commenter asserted that the proposed standard would encourage automation of trash collection and waste disposal operations, and would discourage recycling.

OSHA notes that the final standard requires employers to control problem jobs by modifying the conditions under which the work is performed, including such changes as workstation modification, redesign of tools, and job rotation. The final standard also requires employers to develop ergonomic programs that involve such elements as assessment of problem jobs, modification of jobs to reduce MSD hazards, employee training, and MSD management.

Ergonomics-related job modifications typically result in greater production efficiencies without the need for additional natural resources or the increased discharge of pollutants. As several ergonomists testified at the hearings (David Alexander, Tr. Pp 2142–53, 2369–72 and Dennis Mitchell, Tr. Pp 2366–68) ergonomic modifications typically involve mechanization (*e.g.* the use of carts, shelves, adjustable workstations, etc.) and only rarely involve automation (the replacement of people by machines.) Automation is a rarely-used approach unless the employer considers that process efficiency will be improved. The likelihood is that updated, more energy-efficient production equipment will actually lead to a decrease, not an increase, in energy consumption. In the trash collection and recycling industries, automation and mechanization are increasing because of factors that long predate issuance of this final rule. Mechanization and automation in those industries are likely to produce greater efficiencies and lower costs as well as reducing the risks and costs of employee injuries. OSHA disagrees with the commenter's assertion that recycling would be abandoned on a large scale as a result of OSHA's standard on ergonomics programs; by necessity or law, most local jurisdictions in the U.S. have now committed themselves to recycling.

OSHA believes the claims of adverse environmental effects asserted by the commenter are highly speculative, and fail to make a plausible case that the final Ergonomics Program Standard will significantly affect the human environment. Moreover, none of the impacts predicted by the commenter takes into account any of the environmental benefits that might result from ergonomics-related job modifications, such as productivity increases and waste reduction. Accordingly, OSHA concludes that the final rule will not result in significant environmental impacts and, therefore, an environmental impact statement is not required.

XI. Additional Statutory Issues

1. Fair Notice

Numerous commenters contend that various terms used in the proposed standard are unduly vague and fail to provide fair notice of what the standard requires. For example, the American Iron & Steel Institute asserts that the proposal ''is not written in language that can reasonably be understood by those who must comply with it.'' Ex. 32–206–1. Morgan, Lewis & Bockius believes that several provisions of the proposal ''are unworkably vague in their current state.'' Ex. 30–4467 at p. 6. Organization Resources Counselors, Inc. (ORC) states that the proposal contains an ''excess of complex terms and definitions.'' Ex. 32–78–1 at p. 5. Similar objections were raised by the Edison Electric Institute (Ex. 32–300–1 at p. 6); the Integrated Waste Service Association (Ex. 22–337–1 at p. 8); the National Coalition on Ergonomics (Ex. 32–368–1 at pp. 126–29); the Chamber of Commerce (Ex. 30–1722 at pp. 24–25 & Ex. 500–188 at pp. 66–69); the Forum for a Responsible Ergonomics Standard (Ex. 30–3845 at pp. 26–29); and numerous others. Among the phrases in the proposal the commenters assert were overly vague are ''eliminate or materially reduce the MSD hazards;'' ''significant amount of the employee's worktime;'' ''repeated exposure;'' ''core element;'' ''no cost to employee;'' ''employer commitment;'' ''employee participation;'' ''ergonomic hazard;'' ''persistent MSD symptoms;'' ''forceful lifting/lowering;'' ''problem job;'' ''common sense determination;'' ''ergonomic risk factors;'' ''OSHA recordable MSD;'' ''reasonably likely to cause or contribute to the type of MSD reported;'' ''cold temperatures;'' ''dynamic motion;'' ''awkward posture;'' ''static posture;'' and ''reduce to the extent feasible.'' E.g., Ex. 32–368–1 at p. 126 & Ex. 500–197 at pp. III–3–18 (NCE); Ex. 32–206–1 at pp. 13–14 (American Iron & Steel Institute); Ex. 32–241–4 at pp. 166–80 (Anheuser-Busch and United Parcel Service).

Some of the same commenters, as well as others, object to what they characterize as the proposal's ''one size fits all'' approach. *E.g.,* Ex. 30–3845 at p. 37 (Forum for a Responsible Ergonomics Standard); Ex. 32–368–1 at p. 72 (NCE); Ex. 30–3077 at p. 1 (National Tooling and Machining Association); Ex. 30–2993 at p. 2 (Small Business Legislative Council). They believe it is inadvisable for OSHA to issue a standard that applies to a wide variety of different industries because conditions pertinent to ergonomics vary widely among industries.

The reason OSHA included general language, such as the phrases the commenters contend are too vague, in the proposed standard was to avoid the very ''one size fits all'' approach to which some of the same commenters and many others object. Because of the numerous variables that can result in work-related MSDs, OSHA drafted the proposed rule in flexible, performance-oriented language to enable employers to develop ergonomics programs tailored to their workplaces, rather than attempting to prescribe, for example, the specific manner in which employers should control an MSD hazard. As a result, the proposal used a number of general phrases to allow employers the maximum amount of flexibility consistent with the standard's goal of reducing MSDs.

In response to the numerous comments that criticized the proposed standard as being unduly vague, OSHA has made a number of changes to the final standard that are designed to give additional guidance as to what the standard requires of employers. Some of the complaints most frequently voiced in the comments—that employer obligations are not defined with sufficient clarity—are addressed by (1) changing the scope of the standard to no longer require employers to determine whether their employees are engaged in ''manual handling'' or manufacturing;

(2) including an objective Action Trigger for determining whether an employer must fix a job in which an employee has reported a MSD incident; and (3) establishing compliance endpoints that will enable employers to tell with certainty whether they have taken sufficient steps to fix a problem job. As a result of these changes, certain phrases that commenters claimed were too vague, such as ''significant amount of the employee's worktime,'' ''core element of the job,'' and ''forceful lifting/lowering'' are no longer used. The changes to the final rule, and the reasons for them, are discussed in the Summary and Explanation section of this preamble. Although the final rule contains greater specificity than the proposal, OSHA believes that the final rule still gives employers sufficient flexibility to develop ergonomics programs that are suited to the particular characteristics of their workplaces.

OSHA believes that this final rule provides fair notice to employers of their obligations. On its face, it provides persons of ordinary intelligence a reasonable opportunity to understand the conduct it prohibits or requires. See *Hill* v. *Colorado*, 120 S.Ct 2480, 2498 (2000). Moreover, in addition to the language of the standard and the further guidance provided by this preamble, other sources will be available to help employers determine their compliance obligations. OSHA intends to make compliance assistance conveniently available to the public, both through its website (*www.osha.gov*) and through printed publications. Among the compliance assistance materials will be a small entity compliance guide, as required by the Small Business Regulatory Enforcement Fairness Act of 1996, specifically designed to inform small businesses of their obligations under the rule in language that is readily understandable. Employers and employees will also be able to look to guidelines that have proven successful in averting MSDs in specific industries, such as the red meat guidelines. Ex. 2–13. OSHA-funded consultation services through state agencies will be available to qualifying employers who request it. And personnel in OSHA's national and field offices will be available to answer questions about the standard. OSHA also encourages trade associations and other business organizations to disseminate information, such as case studies of successful ergonomic interventions by employers in their industries, that will help facilitate compliance with the standard by their members.

2. OSHA's Past Enforcement Efforts

In the NPRM, OSHA noted that it had gained experience over the years in addressing ergonomic issues through a variety of means, including enforcement, consultation, training and education, compliance assistance, the Voluntary Protection Programs, and issuance of voluntary guidelines. 64 FR at 65774. In the area of enforcement, the agency had successfully issued over 550 ergonomics citations under the OSH Act's General Duty Clause, section 5(a)(1). *Id.* Almost all of these citations, the agency observed, had led to the implementation of ergonomics programs by the cited employers, included some corporate-wide programs developed pursuant to settlement agreements. *Id.*

The Chamber of Commerce criticizes OSHA for not mentioning cases where, in the Chamber's words, OSHA's enforcement efforts ''abjectly failed.'' Ex. 30–1722 at p. 7. The Chamber states that OSHA lost the ''only three enforcement actions that were actually tried to completion,'' citing Pepperidge Farm, 17 O.S.H. Cas. (BNA) 1993 (Rev. Comm'n, 1997); Dayton Tire, Division of Bridgestone/Firestone, Inc., 1998 WL 99288 (ALJ, 1998); and Beverly Enters., 1994 WL 693958 (ALJ, 1995), review directed (Nov. 9, 1995), decided by the Commission (Oct. 27, 2000). Ex. 30–1722 at pp. 7–8. See also Ex. 500–197 at Ex. III–C, E. Scalia, OSHA's Ergonomics Litigation Record Three Strikes and It's Out, cato inst. No. 391. These cases, the Chamber contends, ''demonstrate the futility of promulgating a mandatory ergonomics program standard, and underscore OSHA's failure to understand the state of the scientific evidence and its legal authority.'' Ex. 30–1722 at p. 10. Similarly, the NCE asserts that litigation of ergonomics citations under the general duty clause demonstrates OSHA's inability to garner sufficient scientific evidence to support an ergonomics rule. Ex. 32–368–1 at p. 14.

Contrary to the Chamber's contentions, OSHA has not ''lost'' the only three ergonomics cases tried to completion. In the case of Beverly Enters., the ''loss'' to which the Chamber refers was an adverse administrative law judge's decision that was under review by the Commission when the Chamber submitted its comments. The Commission has since, in a decision issued on October 27, 2000, reversed the administrative law judge's decision and held that the company's practices for lifting patients in its nursing homes exposed its nursing assistants to a serious recognized hazard. The Commission decision in Pepperidge Farm held that the company's employees were exposed to recognized lifting and repetitive motion hazards. In Dayton Tire, OSHA received an adverse decision from the administrative law judge and decided the case did not present a proper vehicle for appeal. The final order in Dayton Tire is therefore an unreviewed administrative law judge's decision and lacks precedential value. United States v. Sturm, Ruger & Co., 84 F.3d 1, 5 n. 4 (1st Cir.1996); Matter of Establishment Inspection of Cerro Copper Prods. Co., 752 F.2d 280, 284 (7th Cir. 1985); Leone Constr., 3 O.S.H. Cas. (BNA) 1979, 1981 (Rev. Comm'n 1976).

The Chamber contends that the ''unfavorable'' decisions in these three cases undermine the scientific basis for ergonomics regulation and hence for this rule. To the contrary, OSHA believes that the decisions in Beverly and Pepperidge Farm support both the need for and the scientific basis of this rule. They demonstrate that, even under the heavy burden of proof OSHA bears in general duty clause litigation, the preponderance of the credible evidence shows that workplace exposures cause MSDs, that employers recognize this, and that serious injuries result from these exposures.

The Chamber also cites testimony of OSHA witnesses in these cases, along with deposition testimony from Hudson Foods, a case that was ultimately settled, to attempt to show that experts engaged by OSHA cannot state with certainty the degree of risk caused by exposure to different levels of ergonomic stressors (Ex. 30–1722 at pp. 26–27, 47); that OSHA compliance officers are unqualified to evaluate the health risk from ergonomic stressors (Ex. 30–1722 at pp. 28, 64); that experts are unable to define with precision terms such as ''awkward posture,'' ''high force,'' and ''long periods of standing'' (Ex. 30–1722 at pp. 64–69); that two OSHA expert witnesses in Dayton Tire did not offer consistent definitions of the stressors in certain jobs (Ex. 30–1722 at p. 69); and that OSHA experts were unable to testify to the effectiveness of abatement measures (Ex. 30–1722 at pp. 72–73).

The Chamber's reliance on selected testimony in these cases does not undermine the scientific basis for this final rule. First, as the Commission decisions in Beverly and Pepperidge Farm show, the evidence in those cases supports OSHA's decision to address ergonomic hazards in this final rule. Second, even if reasonable experts differ over the nature of ergonomic risks or cannot precisely quantify those risks, OSHA is not precluded from issuing a rule. ''OSHA is not required to support its finding that a significant risk exists with anything approaching scientific certainty.'' Benzene, 448 U.S. at 656. As long as its findings are supported by a body of reputable scientific thought, OSHA may use conservative assumptions in interpreting the evidence and risk error on the side of overprotection rather than underprotection. Id. See also *American Dental Ass'n* v. *Martin*, 984 F.2d 823, 827 (7th Cir.), cert. denied, 510 U.S. 859 (1993) (''OSHA was required neither to quantify the risk to workers health nor to establish the existence of significant risk to a scientific certainty.''). Certainly, the record of this rulemaking contains conflicting evidence on the issues the Chamber raises, such as the relationship between ergonomic stressors and MSDs. However, given the high number of MSDs workers have been suffering and continue to suffer, OSHA does not believe that the lack of a consensus among knowledgeable experts justifies further delay in the issuance of a rule that is needed to protect workers against such ailments. In addition, there is a substantial body of scientific evidence to support the promulgation of an ergonomics standard.

Because the Chamber and other rulemaking participants have argued that Pepperidge Farm and Beverly undermine the basis for this rule, a brief discussion of those cases is appropriate.

Pepperidge Farm

In Pepperidge Farm, the Commission held that the employer willfully violated the OSH Act in requiring its employees to perform hazardous lifts, which caused them to suffer high rates of serious MSDs. The administrative law judge found that the employer's manual lifting tasks, which required the lifting of objects weighing up to 165 pounds, were hazardous, that the company recognized the hazard, and that feasible means of abating the hazard existed. 17 O.S.H. Cas. (BNA) at 2003. The employer did not dispute before the Commission the ALJ's findings that the lifting tasks were hazardous and that abatement was feasible, but argued that it did not recognize the hazard. The Commission rejected the argument, finding that Pepperidge Farm recognized the hazard based on recommendations by its worker's compensation carrier and its own corporate ergonomist. *Id.* at 2003–07. Thus, Pepperidge Farm illustrates, as OSHA has found in this rulemaking, that repetitive lifting of heavy objects is hazardous and that feasible means that will prevent or materially reduce the hazard are available.

The Commission also agreed with OSHA that repetitive motion assembly line tasks posed a recognized hazard. 17 O.S.H. Cas. (BNA) at 2010. Over a three-year period, 28 employees engaged in repetitive motion tasks had undergone 42 separate surgical procedures, including 32 carpal tunnel releases. Id. at 2015. Based on this evidence and on testimony about the rate of carpal tunnel syndrome in the general population, the Commission found that the incidence of carpal tunnel injury caused by repetitive motions performed at the plant was ''substantially in excess of that found in other populations, including other populations of workers.'' *Id.* at 2029. The Commission relied on expert testimony, evidence of biological plausibility, and epidemiological studies, to find that the high rate of MSDs suffered by the employees was caused by their work on the assembly line. *Id.* at 2028–29. The Commission also held that the employer recognized the hazard posed by the repetitive motions because the company's own medical staff attributed the cause of employee disorders to the tasks performed at the facility. *Id.* at 2030. And, the Commission held that the upper extremity musculoskeletal disorders resulting in surgery, disability, and restricted work suffered by employees from their assembly line tasks ''clearly involved serious physical harm.'' *Id.* at 2032. The actual hazard posed to employees from the highly repetitive work, as opposed to a potential hazard, was thus not ''benign,'' as claimed by one writer. Ex. 500–197 at p.12.

Finally, the Commission accepted OSHA's position that Pepperidge Farm was required to follow a process of abatement to eliminate or materially reduce the hazard. 17 O.S.H. Cas. (BNA) at 2034–35. The Commission agreed with OSHA on the core components of such a process—''accurate record keeping, medical treatment for injured employees, workplace analysis to assess the potential hazard and steps to abate it, education and training of workers and management, and further actions, to the extent feasible, to materially reduce the hazard.'' *Id.* at 2034. Under this process, the employer would determine ''precisely what particular mix of engineering and administrative controls most efficiently reduces the [hazard].'' *Id.* at 2033. The Commission found that Pepperidge Farm had in fact followed such a process by implementing a number of engineering and administrative controls and taking the other process steps recommended by OSHA. *Id.* at 2034–38. The Commission concluded that the evidence did not show that the steps taken by the company were inadequate and therefore held that Pepperidge Farm had fulfilled its duty under the general duty clause with respect to the repetitive motion hazards. *Id.* at 2040–41.

Beverly Enterprises

In Beverly Enterprises, OSHRC No. 91–3344 *et al.,* (Rev. Comm'n, Oct. 27, 2000), the nursing assistants (NA's) the company employed in its nursing homes were required to lift patients manually and, in many cases, without assistance. Those employees suffered a disproportionate number of cases of lower back pain (LBP), which was often so severe that the employee would be off work for long periods of time, in some cases six months to over a year. Slip. op. at 16. The administrative law judge concluded that OSHA had not proven that the cases of LBP were caused by Beverly's lifting practices. The ALJ therefore vacated the citation for lack of proof of a hazard.

The Commission reversed the ALJ's decision. The Commission extensively examined the evidence showing that the nurses aides were exposed to the risk of contracting LBP from their lifting activities. The evidence included: (1) The high rate of lost-time cases of LBP suffered by Beverly's NA's; (2) evidence of biomechanical modeling, which evaluated the compressive force imposed by lifts of various weights and body positions on the lower back and calculated the percentage of the working population that could safely perform such lifts; (3) the NIOSH lifting equation, a formula developed for NIOSH for determining a safe level of lift based on data compiled by various researchers on the biomechanical, epidemiological, psychophysical, and physiological bases for LBP; and (4) epidemiological studies showing a correlation between patient lifting and LBP in populations of health care workers. The Commission concluded:

> We find on the scientific evidence presented that manual lifting of residents is a known and recognized risk factor for LBP. Considering also the evidence showing that the frequency and manner in which Beverly's NA's performed their assigned tasks exposed them to compressive forces in excess of limits well-established and accepted in the scientific community, and that Beverly's working conditions resulted in numerous lost-time incidents and prevented Beverly's NA's from performing their usual daily activities, we conclude that the manual lifting of residents was shown on this record to be a hazardous work practice and that Beverly controls the methods used to perform the lifting.

Slip op. at 52.

The Commission further found that Beverly recognized the hazard. Among other evidence, the Commission noted that Beverly had adopted a ''Lift with Care'' program, which referred to the NIOSH limits for safe lifting and taught its NA's how to lift patients in a way that would reduce the likelihood both of injury to the resident and back injury to the NA. *Id.* at 53, 59–60. In addition, Beverly knew its NA's were suffering high rates of LBP from its workers' compensation claims; that failure to use correct lifting techniques is one cause of back injury; and that its nursing homes did not have enough mechanical hoists to ensure that such equipment was available when necessary. Id. at 54–55. Finally, the Commission relied on testimony showing that experts familiar with the nursing home industry perceive lifts such as those performed by Beverly to be hazardous. *Id.* at 62.

The Commission found that the hazard was likely to cause serious physical harm. ''LBP has a substantial and significant effect on the affected employees'' ability to perform their normal activities and effectively disables employees for periods of time which are extensive in some instances. We conclude that in view of the debilitating effect on employees and the potential duration of the disability, LBP is properly considered serious physical harm.'' *Id.* at 68.

The parties disputed before the Commission whether OSHA had proven the feasibility and likely utility of abatement measures. Since the administrative law judge had not made factual findings on that issue, the Commission remanded the case for such findings. *Id.* at 72–73.

Settlements of General Duty Clause Citations

The Chamber of Commerce takes issue with OSHA's claim in the NPRM (64 Fed. Reg. at 65774) that the settlement agreements that resolved most of the contested General Duty Clause citations showed the success of OSHA's enforcement efforts and the efficacy of ergonomics programs. Ex. 30–1722 at pp. 10–12. The Chamber says that employers settle ergonomic citations to avoid the prospect of expensive litigation, and that OSHA therefore cannot conclude that ''those employers ergonomics programs will in fact reduce injury in the workplace, and that, in the absence of OSHA's interventions, the employees in question would have been without protection.'' *Id.* at 10–11. OSHA continues to believe, contrary to the Chamber's assertion, that the settlement agreements are highly significant. While avoidance of the time and expense of litigation undoubtedly entered into those employers' decisions to settle, they nevertheless agreed to put forth substantial efforts to reduce or eliminate the hazards for which they had been cited. For many, the agreements went far beyond the cited locations to other corporate facilities not visited by OSHA and, therefore, far beyond any abatement orders OSHA might have obtained in litigation.

Those agreements and resulting efforts were clearly successful. As noted in the proposed rule preamble, OSHA held a workshop in March 1999, in which ten companies described their experience under their settlement agreement and with their ergonomics programs. All the companies that reported results to OSHA showed a substantially lower severity rate for MSD's since implementing the programs defined in their agreements. Ex. 26–1420. Most companies reported lower workers' compensation costs, as well as higher productivity and product quality. *Id.* Only five of the 13 companies involved in these agreements consistently reported the number of MSD cases or MSD case rates, and all five showed a significant decline in the number of lost workdays. None of the companies that reported severity statistics showed an increase in lost workdays as a result of the ergonomics program.

The success of OSHA enforcement coupled with settlements requiring comprehensive ergonomics programs was confirmed by the United Food and Commercial Workers International Union. The union recognized that ''[t]he majority of our successful programs in the meatpacking and poultry industries were propelled by OSHA enforcement. Ergonomic settlement agreement and corporate-wide settlement agreements (CWSAs) * * * demonstrate industry recognition of the existence of MSD hazards and the elements of a program to prevent worker injuries arising from exposure to these hazards.'' Ex. 32–210–2, p. 5. The UFCW gave a number of examples illustrating the efficacy of these agreements and resulting programs. One was that of IBP's Dakota City meatpacking plant, which implemented a comprehensive program as a result of citations and subsequent settlement agreement. Cost savings attributed to the program ''* * * were realized in the following areas: [employee] turnover was down significantly . * * *; [MSD] incidence dropped dramatically; surgeries fell; [and] worker's compensation costs were reduced significantly.'' *Id.* at 9.

The Chamber of Commerce asserts that a settlement agreement with Hudson Foods is an example of a case that the employer settled despite palpable weaknesses in OSHA's evidence. Ex. 30–1722 at pp. 11–12. The Chamber suggests that OSHA settled for little to get out of litigation that was not going well. In fact, OSHA had developed strong evidence to support the citations and was fully prepared to go to trial if necessary. See generally OSHA's Reply to Hudson Foods. Inc.'s Motion to Exclude Expert Testimony, Secretary v. Hudson Foods, Inc., dated April 30, 1999 (OSHRC Docket No. 98–0079)(Ex. 502–26). However, OSHA was willing to settle because the settlement secured all of its objectives. Hudson, which was purchased by Tyson Foods, Inc. after OSHA's inspection, but before the settlement, withdrew its notice of contest to the ergonomic allegations contained in the citations, paid a total penalty of $200,000 for all citations, and, most importantly, agreed to implement the comprehensive, existing Tyson Foods ergonomics program that the parties anticipated would abate the violations. Ex. 502–42, pp. 3–5, Exhibits ''A'' and B''. With this hazard recognition and gain in employee safety and health, continued litigation over a larger penalty was pointless. The exculpatory language cited by the Chamber was acceptable in light of the intervening purchase of Hudson by Tyson Foods, which had not caused the cited conditions and had displayed good faith through its own implementation of a comprehensive ergonomics program. Ex. 30–4137, p. 1.

OSHA's Red Meat Guidelines

In addition to OSHA's enforcement efforts, many knowledgeable witnesses agreed that the agency's Ergonomics Program Management Guidelines for Meatpacking Plants (''Red Meat Guidelines'') (Ex. 2–13) have resulted in implementation of successful workplace programs addressing ergonomic hazards. For example, in contrasting OSHA's proposal to the Red Meat Guidelines, IBP Inc.''s Bob Wing acknowledged that the Guidelines had been successful. Ex. 30–4046, p. 1. Similarly, the American Meat Institute (''AMI''), the main representative for the U.S. Meat Industry, including 276 meat packers and processors, operating 559 facilities, acknowledged that the industry worked with OSHA on the Red Meat Guidelines and has been using them for nearly ten years. Ex. 30–3677, p. 1. The AMI notes that the Red Meat Guidelines work and that the industry has made substantial progress in addressing ergonomic issues since development of the Guidelines. *Id.* at 1–4. The AMI recommends that the Guidelines be extended throughout general industry. *Id.* at 4. The utility of OSHA's Red Meat Guidelines was also hailed by the United Food and Commercial Workers Union, which noted that upon publication of the Guidelines, industry began to respond both from the standpoint of technology, as well as ergonomic programs. Ex. 32–210–2, pp. 25–26. The success of the Guidelines led to use and acceptance in other industries. The poultry industry appears to have secured substantial reductions in chronic MSD's from adherence to the principles in the document (Ex. 30–3375, p. 1).

Enforcement Actions and Compliance Costs

Some commenters (*e.g.,* Anheuser-Busch and United Parcel Service, Ex. 32–241–4 at pp. 259–266 and the National Coalition on Ergonomics *et al.,* Ex. 500–197 at pp. II–79–84) contend that OSHA's compliance cost estimates ignore the way the agency has enforced ergonomic requirements under section 5(a)(1). The commenters assert that OSHA's estimated costs of compliance with the ergonomics standard are far lower than the costs of the controls OSHA has ''demanded'' in 5(a)(1) enforcement actions.

This argument lacks a factual foundation because it is unsupported by any evidence of the abatement costs associated with the section 5(a)(1) ergonomics citations. In any event, OSHA does not believe those costs are extravagant. In many cases, the abatement measures sought by OSHA were already being used by similarly-situated employers. In Hudson Foods, as discussed above, the settlement agreement simply required Hudson to adopt the ergonomics program of its new owner, Tyson Foods. In Pepperidge Farm, abatement of the lifting violations found by the Commission required the company to do no more than its own corporate ergonomist had recommended. 17 O.S.H. Cas. (BNA) at 2004–06. Similarly, the process for abating the repetitive motion hazards that Pepperidge Farm had already been following was found by the Commission to meet its duty to implement a feasible means of abatement. *Id.* at 2039–41. Thus, the citations in Pepperidge Farm did not require the employer to take additional steps beyond those it was already taking.

Moreover, these arguments reflect a fundamental misunderstanding of the significance of abatement requirements in 5(a)(1) citations and on a mistaken belief that employers who received section 5(a)(1) citations are typical of the employers who will have duties under this standard. Section 5(a)(1) comes into play when there is a serious recognized hazard in an employer's workplace that need not be abated under a specific standard. In order to prove an employer violated section 5(a)(1), OSHA must prove that a recognized hazard that is likely to cause death or serious physical harm exists in the employer's workplace. *Nelson Tree Srvs* v. *OSHRC,* 60 F.3d 1207, 1209 (6th Cir. 1995). OSHA must also specify a means by which the employer can eliminate or materially reduce the hazard and demonstrate the feasibility and likely utility of those means. Id. OSHA can not, however, ''demand'' that an employer abate a 5(a)(1) violation in any particular way. The employer is not limited to using the means listed in the citation to eliminate or materially reduce the hazard but is free to use any means that accomplishes that goal. See OSHA Field Inspection Reference Manual, Ch. A.4.f(2) (''the employer is not limited to the abatement methods suggested by OSHA.''); *Marshall* v. *B.W. Harrison Lumber Co.,* 569 F.2d 1303, 1308 (5th Cir. 1978). An employer will generally have more detailed knowledge of its operations and processes than OSHA will gain during a relatively brief inspection of the workplace and may therefore be able to devise methods of eliminating ergonomics hazards that are more cost effective than those proposed by OSHA. As a result, the costs associated with the means of abatement listed in a citation, even if those costs were quantified in this record, may well be higher than those the employer will actually incur.

For additional reasons as well, the costs associated with section 5(a)(1) citations cannot be used to calculate the costs of this standard. The employers who have been cited for 5(a)(1) ergonomics violations are not representative of the universe of employers who will have compliance duties under the standard. As noted above, to sustain a 5(a)(1) citation, OSHA must be able to prove not only that a hazard is present but that the hazard is one that is recognized by the employer or its industry and is likely to cause death or serious physical harm. Because of this heavy burden of proof, OSHA has only issued 5(a)(1) citations for ergonomic violations to a relatively small number of employers, and those employers have been cited because their employees had been suffering unusually high rates of work-related MSDs. And because the employers cited under 5(a)(1) had particularly severe ergonomics problems, their compliance costs would not be representative of the costs the average employer will incur in complying with the standard.

Moreover, the existence of an ergonomics standard will help reduce compliance costs compared to enforcement of ergonomics protection under section 5(a)(1). It has frequently been observed that reliance on standards is preferable to enforcement under section 5(a)(1) because standards spell out employer duties more specifically than does section 5(a)(1). *E.g., St. Joe Minerals Corp.* v. *OSHRC,* 647 F.2d 840, 846 n.13 (8th Cir. 1981); B & *B Insulation, Inc.* v. *OSHRC,* 583 F.2d 1364, 1371 & n.12 (5th Cir. 1978). That is true of this final rule. For example, unlike section 5(a)(1), this rule establishes safe harbors that will enable employers to know with a high degree of certainty when they have fulfilled their compliance obligations. By providing better notice of employer duties than does section 5(a)(1), the standard will promote the efficient use of employer resources and thereby help minimize costs.

3. Cost-effectiveness.

All OSH Act standards must be cost effective. Cotton Dust, 453 U.S. at 514 n. 32. A standard is cost-effective if the protective measures it requires are the least costly of the available alternatives that achieve the same level of protection. *Id.;* Lockout/Tagout II, 37 F.3d at 668.

OSHA has taken a number of steps to ensure that this final rule is cost-effective. First, the rule allows employers with problem jobs to use any combination of engineering, administrative, and work practice controls to control the MSD hazards. Therefore, from the entire range of controls that would be potentially effective in an employer's workplace, the employer is able to select those that are the least costly.

The standard also ensures the cost-effective use of employer resources by focusing employers' compliance resources where they will do the most good: on those jobs that are demonstrably causing MSDs. It requires all covered employers to provide basic information about MSDs to its employees, but only those employers whose employees experience MSD incidents in jobs that meet the standard's Action Trigger have additional duties. In this regard, the final standard is more cost-effective than the proposal, which would have required all employers engaged in manufacturing and manual handling to implement ergonomics programs.

The Quick Fix option in the final rule also adds to the rule's cost-effectiveness by allowing employers to fix problem jobs without incurring the additional costs of setting up an entire ergonomics program. The Quick Fix option is available for those jobs that can be fixed quickly and completely once the job is identified as a problem job.

The extended compliance dates in the standard will also help minimize employers' compliance costs. Employers are given 11 months from the date of the standard's publication to provide their employees with the basic information the standard requires. Employers will thereby have sufficient time to first become familiar with the standard themselves and then have time to provide the required information to their employees.

Employers are given up to four years from the standard's effective date to complete the implementation of permanent controls for problem jobs. This extended time frame will promote cost-effectiveness in several ways. First, it will give employers sufficient time to learn about the range of available controls, both from the compliance assistance OSHA plans to make available and from other sources. Many employers will thereby be able to implement ''off-the-shelf'' controls, which will be less costly than if the employer needs to develop controls on its own or hire an outside expert to recommend controls. Second, the extended compliance period will enable an employer to adopt an incremental abatement approach that may, in turn, result in less expensive controls than if the employer had to commit itself to a control strategy immediately. For example, an employer can first try a low-cost control and, if it works, would not need to consider higher-cost controls. Third, the extended time frame will enable employers who have more than one problem job to control the highest risk jobs first while still giving them sufficient time to control their other problem jobs. This will enable such an employer to avert more MSDs at an earlier time and thereby minimize its costs for MSD management and worker removal protection.

Finally, OSHA is permitting those employers who already have implemented ergonomics programs meeting certain criteria to continue those programs rather than establish new programs under this final rule. Those employers whose current programs qualify for ''grandfathering'' will therefore not incur any new costs as a result of this final rule.

4. Alleged Conflict With Other Federal Statutes

A number of commenters contend that portions of the standard conflict with other federal laws, in particular the National Labor Relations Act (NLRA), 29 U.S.C. 141 *et seq.*, the Americans with Disabilities Act (ADA), 42 U.S.C. 12101 *et seq.*, the Family and Medical Leave Act (FMLA), 29 U.S.C. 2601 *et seq.*, Title VII of the Civil Rights Act of 1964, 42 U.S.C. s 2000e *et seq.*, and the Age Discrimination in Employment Act (ADEA), 29 U.S.C. 621 *et seq.* The preamble to the proposed standard discussed in some detail the standard's consistency with the NLRA and the ADA, see 64 FR at 65,794–65,795 (NLRA), 66,058–66,059 (ADA), and, as discussed below, the comments do not alter OSHA's conclusion that there is no conflict with those statutes. The proposed preamble did not address the FMLA, Title VII, or the ADEA, but there too we conclude there is no conflict, as discussed below.

a. National Labor Relations Act—NLRA's prohibition on employer-dominated labor organizations in nonunion workplaces. Various provisions of the standard require employers to convey information to their employees and obtain information from their employees. Paragraph (i), governing employee participation, requires that employees: (1) Have ways to promptly report MSDs, their signs and symptoms, and MSD hazards in the workplace; (2) receive prompt responses to their reports of MSD signs and symptoms and MSD hazards; (3) have ready access to the standard and to information about MSDs, MSD signs and symptoms, and the employer's ergonomics program; and (4) have ways to be involved in developing, implementing and evaluating the ergonomics program. Paragraph (j) requires an employer analyzing a problem job to talk with affected employees and their representatives about the tasks they perform that relate to MSDs. Paragraph (m) provides that an employer required to control a problem job must ask employees and their representatives for recommendations about reducing the MSD hazards and consult with employees and their representatives about the effectiveness of the controls the employer implements. Paragraph (o) provides that an employer who chooses the Quick Fix option must ask employees and their representatives for recommendations about reducing the MSD hazards. Paragraph (t) requires the employer to train employees in the aspects of the ergonomics program that affect them and to give the employees the opportunity to ask questions about the ergonomics program. Paragraph (u) requires employers to consult with employees and their representatives about the effectiveness of the program and any problems with it.

Some commenters contend that the requirement for employee participation in an ergonomics program, to the extent it applies in nonunion workplaces, would conflict with section 8(a)(2) of the NLRA, which prohibits employers from dominating or interfering with a labor organization. Ex. 32–368–1 at pp. 124–26 (National Coalition on Ergonomics); Ex. 32–234–2 at pp. 29–30 (National Solid Waste Management Association); Ex. 30–3845 at p. 36 (Forum for a Responsible Ergonomics Standard). The National Coalition on Ergonomics (NCE) states that because the standard requires that employers provide ways for employees to be involved in developing, implementing, and evaluating ergonomics programs, the standard is an ''open invitation'' to violate Section 8(a)(2). Ex. 32–368–1 at p 126. NCE also asserts that requiring employers to respond to employee reports of MSD symptoms would require conduct violating Section 8(a)(2). Id.

These arguments are without merit. Nothing in the standard requires creation of any sort of employee organization or committee, let alone one that violates the NLRA. Section 8(a)(2) of the NLRA does not restrict the ability of nonunion employers to deal with employees as individuals, and such employers can comply fully with the standard's employee participation provisions by doing so. Contrary to NCE's contention, the requirement that employers respond to employee reports of MSD symptoms does not violate the NLRA. Even before the passage of the OSH Act, it was common for employees to report injuries to employers, and for responsible employers to respond to those reports by correcting workplace hazards. See Taft Broadcasting Co., Kings Island Div., 13 O.S.H. Cas. (BNA) 1137, 1140 (Rev. Comm'n 1987), aff'd, 849 F.2d 990 (6th Cir. 1988). It has never been suggested that such actions violate the NLRA, and they clearly do not.

Moreover, nonunion employers can use a variety of other means to comply with the employee participation provisions of the standard without running afoul of section 8(a)(2)'s proscription against dominating or interfering with the formation or administration of any labor organization. A ''labor organization'' under the NLRA is ''any organization of any kind, or any agency or employee representation committee or plan, in which employees participate and which exists for the purpose, in whole or in part, of dealing with employers concerning grievances, labor disputes, wages, rates of pay, hours of employment, or conditions of work.'' 29 U.S.C. § 152(5). A critical component of this definition is that the organization or committee ''deal[] with'' an employer. Such ''dealing'' occurs if there is a ''bilateral process'' that entails a pattern or practice by which a group of employees makes proposals to management and management responds to those proposals by acceptance or rejection by word or deed. EFCO Corp., 327 N.L.R.B. No. 71 (Dec. 31, 1998), aff'd, *EFCO Corp.* v. *NLRB,* 2000 WL 623436 (4th Cir. 2000) (unpublished); Electromation, Inc., 309 N.L.R.B. 990 (1992). However, if there are only isolated instances in which a group makes ad hoc proposals to management, the element of dealing is lacking. E.I. du Pont de Nemours & Co., 311 N.L.R.B. 893, 894 (1993).

In its preamble to the proposed rule, OSHA carefully explained that the requirement that employees have ways of being involved in the ergonomics program can be satisfied by measures that fall short of the employer-dominated committees and other employee organizations that violate Section 8(a)(2). In general, the agency emphasized that the ''nature, form, and extent of how employers must provide employees with opportunities to participate will vary among workplaces,'' depending upon a variety of factors, including ''[t]he presence or absence of a union.'' 64 FR at 65,800. In particular, it explained that OSHA has been careful to structure the ''employee participation requirements so that they are entirely consonant with the case law based on the NLRA.'' 64 FR at 65,795. Thus, the agency explained that the proposed rule does not ''mandate any particular method '' such as employee committees '' for ensuring employee participation,'' and that this ''leaves employers free to involve employees in the program in ways that do not violate the NLRA but will further meaningful employee participation.'' *Id.*

Moreover, OSHA has already explained that there are various permissible ways to meet the requirement that employees be involved in developing, implementing, and evaluating ergonomics programs. The preamble to the proposed standard pointed to certain methods of obtaining employee input through employee group activity—a brainstorming group, an information-gathering committee, or a safety conference—that is structured so as not to ''deal with'' the employer, within the meaning of Section 8(a)(2). See 64 FR at 65,795 (discussing Ex. 26–29: May 13, 1999 testimony of Henry L. Solano, Solicitor of Labor, to the Subcommittee on Workforce Protections, Committee on Education and the Workforce in the House of Representatives). In addition, the preamble noted that employers can provide mechanisms for individual employees to report problems and make recommendations, or can assign safety responsibilities to employees as part of their job descriptions, without implicating Section 8(a)(2). *Id.*

The NCE questions whether ''brain-storming'' groups or ''information-gathering'' committees would actually fall outside the scope of Sections 2(5) and 8(a)(2). Ex. 32–368–1 at p. 126. These types of entities are specifically mentioned in NLRA case law as ones that would pass muster. See E.I. du Pont, 311 N.L.R.B. at 894, cited in Ex. 26–23, pp. 11–12; see also EFCO Corp., 327 N.L.R.B. No. 71, slip op. 5 (''[a] significant portion of the purposes and functions of the Safety Committee, such as the reporting and correction of safety problems, would not contribute to a finding that it is a labor organization''); *id.* (employee suggestion screening committee did not ''deal with'' employer because it merely reviewed and forwarded suggestions without formulating proposals or presenting them to management). Nor does the fact that the proposed preamble elsewhere refers to an ''ergonomics committee'' or a ''labor-management CTD committee'' as effective components of an ergonomics program suggest that the agency is being ''disingenuous,'' as NCE charges. Ex. 32–368–1 at p. 125 n. 228. The general reference to an ''ergonomics committee'' does not suggest that OSHA, contrary to its express statements, requires employers to institute employee committees that violate Section 8(a)(2), and the reference to a joint-labor management committee is consistent with OSHA's statement that a permissible mechanism for employee participation in unionized workplaces, consistent with the proposed standard and the NLRA, is a ''joint labor-management committee established in compliance with the NLRA by bargaining between the employer and the union representing the employees.'' 64 FR at 65,795.

Impact on collective bargaining agreements in unionized workplaces. As to unionized settings, the Chamber of Commerce contends that the proposed rule would force employers to run afoul of the NLRA and the Railway Labor Act because it would require employers to make unilateral changes in mandatory subjects of bargaining, thereby subjecting them to unfair labor practice charges under section 8(a)(5) of the NLRA, labor unrest, and possible criminal penalties. Ex. 30–1722 at p. 82. The NCE and others say that unionized employers would be forced into direct dealing with represented employees and will thereby violate section 8(a)(5). Ex. 500–197 at pp. III–53–61. Similarly, the Edison Electric Institute (EEI) reads the proposed standard as requiring employers to deal with individual employees regarding their working conditions and contends that this requirement ''creates the seeds of conflict with the exclusive bargaining authority of recognized unions under Section 9(a) of the [NLRA].'' Ex. 32–300–1 at p. 9. The Integrated Waste Services Association (ISWA) makes a similar argument. Ex. 22–7–1 at pp. 16–17. EEI and ISWA urge OSHA to make clear in the final rule that where employees are represented by a certified bargaining representative, employers will satisfy the employee involvement provisions of the standard by dealing in good faith with the union. Ex. 32–300–1 at p. 11 (EEI); Ex. 22–337–1 at p.17 (ISWA).

As discussed elsewhere in this preamble, employee participation in an ergonomics program is a vital component of an effective program. OSHA further believes that unions, where they exist, must be involved in the program and has therefore provided that ''representatives'' of employees be afforded the opportunity to participate in job hazard analyses, recommendations for controls, and program evaluation. Cf. OSHA Field Inspection Reference Manual, Ch. II, Sec. A.3.f (where employees are represented by a recognized union, the highest ranking on-site union official or union employee representative designates who will represent employees during a walkaround inspection); OSHA Instruction CPL 2–2.45A (Sept. 13, 1994), Process Safety Management of Highly Hazardous Chemicals—Compliance Guidelines and Enforcement Procedures, Appendix B (''employee representative'' under employee participation provision of process safety management standard, 29 C.F.R. 1910.119(c), refers to recognized union). Thus, rather than bypassing unions, the standard provides that they play an important role.

For example, the employer must, under paragraph (m), ask the ''employees and their representatives'' for recommendations about how to best eliminate or control MSD hazards. The requirement that employers ask ''employees and their representatives'' for such recommendations does not mean that a unionized employer must deal separately with its represented employees and their union. That language is intended to encompass the entire range of workplaces, including nonunion workplaces, unionized workplaces in which all of the employees in problem jobs are represented by the union, and workplaces in which some of the employees in problem jobs are represented by the union and some are not. In workplaces in which all employees in a problem job are within the bargaining unit, employers may, as EEI and ISWA suggest, fulfill their obligations under the provisions that require the involvement of ''employees and their representatives'' by dealing in good faith with the union. The employer and union may agree on any mechanism for employee participation that is consistent with the standard.

Some commenters note that ergonomic provisions have been incorporated into collective bargaining agreements and assert that employers may be forced to violate these agreements to comply with the rule. Ex. 30–1722 at p. 82 (Chamber of Commerce); Ex. 500–197 at p. III–62 (National Coalition on Ergonomics and others). The duty to bargain with recognized unions over safety and health matters does not excuse employers from complying with OSH Act standards. Employers and unions cannot bargain away an obligation under the Act. See *Trans World Airlines* v. *Hardison*, 432 U.S. 63, 79 (1977) (''neither a collective-bargaining contract nor a seniority system may be employed to violate the statute.''); *Alexander* v. *Gardner Denver Co.*, 415 U.S. 36, 51 (1974) (notwithstanding contrary provision of collective bargaining agreement, employee has right to court hearing on race discrimination claim under Title VII). See generally *United Steelworkers* v. *Marshall*, 647 F.2d 1189, 1236 (D.C. Cir. 1980), cert. denied, 453 U.S. 913 (1981) (''[i]n passing a massive worker health and safety statute, Congress certainly knew it was laying a basis for agency regulations that would replace or obviate worker safety provisions of many collective bargaining agreements''), cert. denied, 453 U.S. 913 (1981); see also Murphy Oil USA, Inc., 286 NLRB 1039, 1042 (1987) (employer can unilaterally adopt work rule required by OSHA standard without bargaining with union); *Louisiana Chem. Ass'n* v. *Bingham*, 550 F. Supp. 1136, 1144 (W.D. La. 1982), aff'd, 731 F.2d 280 (5th Cir. 1984). Thus, if there is an irreconcilable conflict between the standard and a collective bargaining agreement, the standard would prevail.

The possibility that existing collective bargaining agreements address ergonomics does not, as the Chamber of Commerce suggests, place employers in an untenable position. If such collectively bargained programs meet the standard as adopted or qualify under the standard's grandfather clause, they will not need to be altered. If they conflict with the standard, the employer's statutory obligation to comply with the standard takes priority over the agreement. Murphy Oil, 286 NLRB at 1042 (employer ''was not only within its rights, but also legally bound to adopt a rule that complied with Federal law.''); Standard Candy Co., 147 NLRB 1070, 1073 (1964) (employer was legally obligated to raise wages to new federally-mandated minimum wage without bargaining with union).

To the extent the employer has discretion in the means by which it achieves compliance, and the means involve a mandatory subject of bargaining, the employer would be required to bargain with the union regarding the means of compliance. United Steelworkers, 647 F.2d at 1236 (''[w]hen an issue related to earnings protection not wholly covered by OSHA regulation arises between labor and management, it will remain a mandatory subject of collective bargaining''); see Watsonville Newspapers, LLC, 327 N.L.R.B. No. 160, slip op. 2–3 (Mar. 24, 1999); Dickerson-Chapman, Inc., 313 N.L.R.B. 907, 942 (1994) (although employer must comply with OSH Act standard requiring daily inspections of open excavations by a ''competent person,'' employer must bargain with union about who would be so designated); Hanes Corp., 260 N.L.R.B. 557, 561–562 & n.12 (1982) (where OSHA standard required use of respirators but gave employer discretion with respect to choice of respirator, employer could require use of respirator without bargaining, but could not unilaterally determine which approved respirator would be used). Nothing in the ergonomics program standard forecloses employers from bargaining with unions about discretionary aspects of the standard that are mandatory subjects of bargaining under the NLRA. To the contrary, OSHA has repeatedly emphasized the importance of involving employee representatives in all aspects of the ergonomics program. As the AFL–CIO points out:

> The reality is that since the OSHAct's passage, employers and unions have been able to meet both their responsibilities under OSHA's standards and their duty to bargain under the NLRA. Unions have a strong interest in dealing with employers over safety and health matters, and will eagerly deal with employers over ergonomics. The record reflects extensive union-management efforts to tackle ergonomic hazards. Thus, the notion that the employer's bargaining obligation stands in the way of OSHA compliance does not reflect reality. Ex. 500–218 at p. 162.

The National Coalition on Ergonomics argues that imposition of some of the controls suggested by OSHA could violate seniority and line of progression provisions in collective bargaining agreements. Ex. 32–368–1 at p. 81. The NCE is apparently referring to the standard's inclusion of employee rotation in the definition of ''administrative controls.'' The NCE also claims that employees being rotated into other jobs may not be qualified to perform those jobs and that job rotation can create a greater hazard by subjecting employees to the risk of new MSD risk factors they were not exposed to in their prior jobs. Id.

These objections are unpersuasive. First, many workplaces are not covered by collective bargaining agreements that contain seniority or line of progression limitations. In those workplaces, the concerns raised by NCE are totally absent. Second, the standard does not require any employer to use job rotation. To the contrary, it specifically states that engineering controls, where feasible, are to be preferred over administrative controls, including job rotation. However, to give employers maximum flexibility, the standard gives employers the option of using administrative controls. As a result, those employers who can use job rotation safely and effectively are free to do so, while those who believe job rotation would lead to contractual or safety problems can address ergonomic hazards in other ways.

b. Americans with Disabilities Act. The ADA is an anti-discrimination statute that prohibits discrimination by covered employers against ''qualified individual[s] with a disability,'' that is, persons ''with a disability who, with or without reasonable accommodation, can perform the essential functions of the employment position that such individual holds or desires.'' 42 U.S.C. 12111(8), 12112(a). Under the ADA, employers must reasonably accommodate disabled workers. However, if there is no reasonable accommodation that would permit a disabled employee to work for the employer, the employer is free to discharge the employee under the ADA.

Commenters argue that the proposed standard improperly requires employers to take steps beyond those required by the ADA in that the standard's requirement that employers control ergonomics hazards requires steps beyond ADA's requirement for reasonable accommodation. Ex. 32–368–1 at p. 118 (NCE); Ex. 30–1722 at p. 81 (Chamber of Commerce). These comments are fundamentally misguided.

In the preamble to the proposed rule OSHA explained its authority under the OSH Act for promulgating this standard. In order to achieve the Act's purpose of assuring ''safe and healthful'' workplaces, 29 U.S.C. 651(b), the Secretary of Labor is authorized to promulgate health and safety standards, *id.* § 655(b), which may require ''conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment.'' *Id.* § 652(8). Pursuant to this authority, see 64 FR at 65,774–65,775, OSHA has determined, based on the best available evidence, that the various components of the ergonomics standard are reasonably necessary and appropriate to provide adequate protection from hazards that are reasonably likely to cause or contribute to work-related MSDs. It is on the basis of this authority that OSHA is requiring employers to take such actions as analyzing jobs to identify MSD hazards, implementing measures to control such hazards, and removing a disincentive to reporting MSDs by providing economic protection for workers who are placed on temporary work restrictions or removed from work because of MSDs related to their jobs. See generally 64 FR at 65,838–65,861. Nothing in the ADA limits OSHA's authority under the OSH Act to issue standards that are reasonably necessary and appropriate to protect worker health and safety.

The ADA's definition of disability is not keyed to impairments that are occupational in origin, but more generally encompasses impairments (whatever their origin) that substantially limit (or are regarded as limiting) an individual's major life activities. 42 U.S.C. §§ 12111(10), 12112(b)(5)(A). Reasonable accommodations to such impairments may include ''job restructuring, part-time or modified work schedules, reassignment to a vacant position, acquisition or modification of equipment or devices'' and other similar accommodations. *Id.* § 12111(9)(B). Employers are not required, however, to provide accommodations that would pose undue business hardship, which is defined as ''an action requiring significant difficulty or expense, when considered in light of'' certain statutory factors. *Id.* §§ 12111(10), 12112(b)(5)(A).

As OSHA explained in the preamble to the proposed standard, the ergonomics standard and the ADA are complementary in purpose. 64 FR at 66,058–66,059. The standard implements measures in problem jobs that would reduce the likelihood of those jobs causing or aggravating MSDs (a category that includes impairments that may be disabilities under the ADA, although it also includes impairments that do not rise to the level of an ADA-covered disability). These measures will not only prevent MSDs within the meaning of the ergonomics standard, but also make it easier for persons with existing impairments (including ADA-covered disabilities) to work in those jobs. Accordingly, the standard comports well with the ADA's goal of reducing barriers to the employment of individuals with disabilities.

Notwithstanding this complementary purpose, the NCE and the Chamber of Commerce argue that the standard impermissibly conflicts with the ADA because it may require employers to make changes to jobs it is not required to make under the ADA. Ex. 32–368–1 at p. 118 (NCE); Ex. 30–1722 at p. 81 (Chamber). This contention is meritless. As noted, the ergonomics standard is squarely based on OSHA's authority to promulgate health and safety standards. Moreover, although the NCE and the Chamber suggest that the ADA prohibits OSHA from requiring changes to jobs beyond the reasonable accommodations required under the ADA, nothing in the ADA even remotely supports this proposition. 29 C.F.R. pt. 1630 app. at 354 (''nothing in [EEOC ADA regulations] prohibits employers * * * from providing accommodations beyond those required by th[e]'' regulations).

Similarly, nothing in the ergonomics standard conflicts with the ADA. The standard does not purport to authorize discrimination that is prohibited by the ADA; nor does it purport to eliminate any defenses that an employer may have to an ADA action. NCE's charge that OSHA is attempting to eliminate defenses under the ADA is based on a misunderstanding of the thrust of the pertinent agency statements in the preamble to the proposed standard. Ex. 32–368–1 at p. 121; see 64 FR at 66,059–66,060. OSHA explained that the ergonomics standard, by requiring employers to control problem jobs, ultimately should make it easier for employers to hire persons with MSD-related disabilities and should lessen the incidence of MSDs. The standard should therefore lessen the number of occasions on which employers would need to raise defenses under the ADA, such as that the accommodation involves an undue hardship or that the disabled person is a direct threat, see 42 U.S.C. 12113(b), to the health or safety of others that cannot be eliminated by the reasonable accommodation. 64 FR at 66,060. This salutary effect does not establish a conflict with the ADA and provides no ADA-based reason for not implementing the standard.

NCE argues that a provision in the proposal (proposed section 1910.132(a)(2)) conflicts with the ADA by requiring employers to keep confidential certain information pertaining to an employee's medical condition that the employer could, under limited circumstances, release under the ADA. Ex. 32–368–1 at pp.119–20. The proposed provision would have required confidentiality ''to the extent permitted and required by law,'' avoiding any possible conflict with another statute's disclosure requirement. The provision has been deleted from the final standard because, as NCE notes, it is superfluous. Ex. 32–368–1 at p.120.

NCE also objects to a provision in the proposed standard providing that the employer instruct the health care provider (HCP) that diagnoses unrelated to workplace exposure to MSD must remain confidential and must not be included in the opinion communicated to the employer. Ex. 32–368–1 at p.119. This provision has been carried over into the final standard (with the addition of an exception as discussed below). Although NCE appears to contend that this provision also conflicts with the ADA's confidentiality exceptions, it offers no cogent reason why this is so. OSHA continues to believe, as it explained in the preamble to the proposed standard, that a provision protecting the confidentiality of medical conditions that are not workplace-related is needed to protect employees' privacy and, for that reason, has been a routine feature of OSHA health standards for many years. 64 FR at 65,844. Such a confidentiality provision is reasonably necessary to encourage employee reporting of MSD hazards because employees could be deterred from such reporting if they knew information about their medical condition would be improperly disclosed. Thus, the agency clearly has the authority to adopt such a provision. Moreover, OSHA has added language to the provision clarifying that it is subject to an exception: the information may be communicated where authorized by federal or state law.

Finally, the NCE contends that compliance with the proposed standard could subject employers to discrimination claims under the ADA. NCE argues that because the ergonomics standard may require employers to alter jobs to a greater extent than does the ADA's reasonable accommodation requirement, persons with non-MSD disabilities may claim that the employer has engaged in disparate treatment by providing more extensive accommodations for MSD disabilities than non-MSD disabilities. Ex. 32–368–1 at p. 119. Even assuming that allegations of differing degrees of accommodation for different disabilities states a viable claim of disparate treatment under the ADA, the employer would have a defense to such a claim. EEOC regulation, 29 CFR 1630.15(e), recognizes that ''[i]t may be a defense to a charge of discrimination under this part that a challenged action is required or necessitated by another Federal law or regulation.'' The employer's obligation to comply with the ergonomics standard would constitute a legitimate, nondiscriminatory reason explaining the difference between its treatment of disabilities also covered under the ergonomics standard and its treatment of other disabilities. See generally id. pt. 1630, app. at 369 (necessity of compliance with federal law or regulation a defense, where not a pretext for discrimination).

OSHA emphasizes that this final standard does not limit an employer's obligation to comply with the ADA. If an HCP advises the employer, pursuant to paragraph (r)(2)(ii) of the standard, that an employee with a MSD can never resume his or her former work activities, any obligations the employer has toward that employee under the ADA would remain in effect.

c. Family and Medical Leave Act. Under the FMLA, an ''eligible employee'' is entitled to take up to a total of 12 work weeks of unpaid leave for the birth of a child and to care for such child, for the placement of a child for adoption or foster care, to care for a spouse or an immediate family member with a serious health condition, or when he or she is unable to work because of a serious health condition. See 29 U.S.C. 2612(a)(1). In response to the proposed standard, the Chamber of Commerce and the NCE pointed out that, while the FMLA only requires employers to provide 12 weeks of unpaid leave to employees with serious health conditions, the proposed standard's provisions for work restriction protection provided that an employee unable to continue in his or her current job due to a work-related MSD may be placed on leave for up to 6 months [90 days in the final rule] with 90% of pay. The Chamber states that the agency has not explained how ''it acquired the authority to enact a regulation that would make Congressional policies embodied in the FMLA irrelevant for OSHA's preferred class of employees,'' Ex. 30–1722 at p. 82. The NCE similarly contends that ''OSHA cannot supersede the requirements of another federal statute without express statutory authority,'' Ex. 32–368–1 at p. 124. Similar arguments are made by the National Solid Wastes Management Association (Ex. 32–234–2 at p. 28); and Paul, Hastings, Janofsky & Walker LLP (Ex. 32–211–1 at pp. 10–11);

As with the ADA, there is nothing in the FMLA or its implementing regulations that suggests any restriction on OSHA's authority to regulate workplace safety and health. Nor is there anything in the ergonomics standard that would cause an employer to violate the FMLA. There is thus no FMLA-based obstacle to adoption of the standard. Moreover, the FMLA requires employers to accommodate employees' need for time off to care for their own or their family's health. The ergonomics rule will prevent many incipient MSDs from progressing to the type of serious health conditions that might justify leave under the FMLA and will thereby reduce the need for employees to invoke the FMLA's protections. Thus, as with the ADA, the ergonomics standard works in concert with, not against, the purposes of the FMLA.

The NCE raises some questions about the interplay between the FMLA and the standard's work restriction protection (WRP) provisions. Ex. 32–368–1 at p. 123. NCE asks, for example, whether an employee could receive six months of WRP payments while removed from work and then obtain an additional 12 weeks of unpaid leave under the FMLA. FMLA regulations provide that an employer may in specified circumstances designate paid leave as FMLA leave. 29 CFR 825.208. Nothing in the ergonomics standard precludes an employer from designating WRP-leave as FMLA leave if the limited circumstances under which paid leave may be designated as FMLA leave are met.

NCE also contends that the ergonomic standard's provisions regarding opinions of health care providers (HCPs) conflict with FMLA regulations regarding medical certifications for the existence of a serious health condition. Ex. 32–368–1 at p. 123; citing 29 U.S.C. 2613. See also 29 CFR 825.305–825.308. The ergonomics standard does not preclude employers from making use of the FMLA medical certification provisions when questions arise as to the application of the FMLA to an employee with an MSD-based condition. We note, however, that in the scenario with which NCE seems most concerned—the employee who is on paid WRP-leave—it is highly unlikely that there will be a bona fide dispute about whether the employee has a serious health condition that has rendered him or her unable to perform the functions of the job. See 29 CFR 825.114(a)(2) (serious health condition includes condition that causes more than three consecutive calendar days of incapacity and involves either two visits to a HCP or one visit followed by a regimen of continuing treatment under the HCP's supervision), 825.115. In other words, it is implausible that an employee on paid WRP-leave would resist the employer's designation of the leave as FMLA-leave on the ground that he or she does not have a serious health condition.

NCE also contends that compliance with the proposed standard could subject employers to discrimination claims under the FMLA because workers covered by the standard may receive WRP consisting of paid leave, while other workers with serious health conditions who are unable to perform their job are entitled only to unpaid leave under the FMLA. NCE 123–124. The FMLA's anti-discrimination provision, however, does not sweep so broadly. It prohibits interference with the exercise of rights under that statute, 29 U.S.C. 2615(a)(1), and proscribes discrimination against an individual for having engaged in activity such as opposing unlawful practices under the statute, filing charges, or giving information or testifying in connection with FMLA proceedings or inquiries. 29 U.S.C. 2615(a)(2), (b). An employer who has placed employees on paid WRP-leave under the ergonomics standard has not, by that action, interfered with other employees' FMLA rights. Nor would its reason for not giving similar paid leave to those other employees—that the employees were outside the scope of the WRP provisions of the ergonomics standard—constitute a basis of prohibited discrimination under the FMLA (such as retaliation for protected activities).

d. Title VII of the Civil Rights Act of 1964 and the ADEA. Title VII prohibits employment practices and devices that discriminate on the basis of race, color, religion, sex, or national origin. The ADEA prohibits employment discrimination on the basis of age. The

Forum for a Responsible Ergonomics Standard contends that women and older workers are more susceptible to MSDs than younger persons and that the ergonomics standard will therefore encourage employers to violate these statutes by hiring a young, male-dominated workforce. Ex. 30–3845 at pp. 36–37.

These anti-discrimination statutes were adopted to combat the attitudes prevalent among many employers that older workers, or female workers, or minority workers, were not as qualified to do a job as well as young, white males. Through their enactment, Congress prohibited employers from relying on such outdated stereotypes rather than making hiring decisions on the basis of a worker's individual capabilities. See *Hazen Paper Co.* v. *Biggins,* 507 U.S. 604, 610 (1993) (''Congress promulgation of the ADEA was prompted by its concern that older workers were being deprived of employment on the basis of inaccurate and stigmatizing stereotypes.''); *Los Angeles Dept. of Water & Power* v. *Manhart,* 435 U.S. 702, 707 n. 13 (1978) (''In forbidding employers to discriminate against individuals because of their sex, Congress intended to strike at the entire spectrum of disparate treatment of men and women resulting from sex stereotypes.'').

In particular, these statutes preclude discriminatory hiring decisions based on perceived gender or age-based susceptibility to a safety or health risk inherent in the job. In *UAW* v. *Johnson Controls, Inc.,* 499 U.S. 187 (1991), the Supreme Court held that an employer's ''fetal protection policy'' violated Title VII. Under that policy, the employer refused to assign women to jobs involving lead exposure unless the women could show they were unable to become pregnant. The employer claimed that this policy was justified because lead in a pregnant woman's bloodstream could potentially harm the fetus. The Supreme Court held that the employer's concern that women who were or might become pregnant would be particularly susceptible to a health risk from lead exposure was not a valid reason to allow them to exclude such women from jobs for which they were qualified.

The rulemaking record shows that workers of both sexes and all ages suffer MSDs when exposed to high levels of the risk factors addressed by this standard. OSHA therefore does not believe that the rulemaking record supports the commenters' claim that this standard will provide any incentive to employers to violate Title VII and the ADEA. However, even if some employers believe they can gain some benefit by hiring only young, male workers, Title VII and the ADEA prohibit them from doing so on the basis that it will make compliance with the standard easier.

XII. Procedural Issues

I. Introduction

OSHA began seeking public participation in this rulemaking when it published an Advance Notice of Proposed Rulemaking (ANPR) in August 1992. The Agency received more than 250 comments in direct response to that notice. See Comments in Ex. 3. The next year OSHA conducted an extensive survey of employers to obtain information on the extent of existing ergonomics programs and practices in general industry. In 1994–1995, and again in 1998 and 1999, OSHA held a series of ''stakeholder meetings'' across the country where interested members of the public discussed with representatives of OSHA their experiences and opinions relating to ergonomics and ergonomic programs. See Ex. 26–1370. In some cases, OSHA even shared early drafts of regulatory text under consideration with participants in these meetings.

In developing the proposed standard, OSHA took account of all the information it had obtained during this period: the ANPR comments; the survey responses; and the stakeholders' views and experience, as well as its own enforcement experience and information gleaned from a comprehensive review of the relevant literature. In response to this input, OSHA revised its regulatory approach substantially from that reflected in its early drafts of a standard. In February 1999, as part of the review process required by the Small Business Regulatory Enforcement Fairness Act (SBREFA), 5 U.S.C. § 601 *et seq.*, OSHA released to the public a draft proposed Ergonomics Program standard (SBREFA draft) that reflected much of the regulatory approach of the proposal. The SBREFA draft was also made available on OSHA's website. OSHA received a large amount of feedback on this draft from the small entity representatives participating in the SBREFA process, and OSHA made a number of alterations to the draft based on that feedback. See Ex. 23.

As described in detail below, OSHA's official Notice of Proposed Rulemaking provided the public with additional opportunities to participate in the rulemaking. Specifically, OSHA established a 70 day pre-hearing comment period (later extended to 100 days), during which the public could comment and submit evidence on all aspects of the proposed standard. OSHA also scheduled a nine week informal public hearing, for interested parties to testify on the proposed standard. Finally, OSHA established a 90 day post-hearing comment period. The post-hearing comment period gave hearing participants 45 additional days to submit data and evidence, and 90 additional days to submit comments for consideration by OSHA. In sum, those individuals who participated in the informal public hearing had 216 days (more than seven months) after publication of the proposed rule to submit data and evidence to the rulemaking record for OSHA's consideration, and 261 days (nearly nine months) after publication of the proposed rule to submit briefs and arguments to the rulemaking record.

Although these procedures exceed the legal requirements for OSHA rulemaking and are consistent with the procedures used in past Agency rulemakings, a number of participants, primarily employer groups, have attacked them as inadequate. A major theme of these attacks is that the issues in this rulemaking are unprecedentedly complex, and that OSHA therefore should have provided extraordinary comment periods and other opportunities to challenge its preliminary conclusions. OSHA recognizes that the size of the record on some issues could have posed challenges, although by no means insurmountable ones, to rulemaking participants. OSHA responded to these challenges by making adjustments to the rulemaking schedule and to the procedures used in earlier rulemakings in order to provide interested parties with easier access to rulemaking materials (including extending Docket Office hours), and to ensure that the rulemaking proceeded in a fair and orderly manner.

II. The Adequacy of the Rulemaking Process

A. Length of the Pre-Hearing Comment Period

OSHA published its proposed Ergonomics Program standard on November 23, 1999. 64 FR 65768 (Nov. 23, 1999); see also 64 FR 73448 (Dec. 30, 1999) (publication of corrections notice). In the **Federal Register** notice, OSHA established a 70 day pre-hearing comment period to submit written comments and evidence on the proposed standard. *Id.* These materials were required to be postmarked by February 1, 2000. *Id.*

OSHA received a number of requests to extend the pre-hearing comment period and delay the informal public hearing. See *e.g.,* Letters in Ex. 33. In response to these requests, OSHA extended the pre-hearing comment period an additional 30 days, until March 2, 2000, and delayed the start of the informal public hearing by 20 days, until March 13, 2000. 65 FR 4795 (Feb. 1, 2000). This schedule gave interested parties a total of 100 days to submit pre-hearing comments on the proposed standard. OSHA also notified participants of a number of innovations in its filing and docket access procedures, so that parties would have as little difficulty as possible in reviewing the record and filing comments in the time allowed. See Ex. DC–423. For example, OSHA placed copies of the proposed rule, the full Health Effects section, and the full Preliminary Economic Analysis on its webpage and on CD–ROM. OSHA mailed a CD–ROM free of charge to all individuals who had participated in earlier stakeholder meetings and to any other interested party upon request.

The 100-day pre-hearing comment period was more than three times as long as that required by the OSH Act. The OSH Act only requires OSHA to give interested parties 30 days to comment on a proposed standard. 29 U.S.C. 655(2). OSHA's procedural regulations also state that a proposed rule must provide interested persons with 30 days in which to submit ''written data, views, and arguments, which shall be available for public inspection and copying.'' 29 CFR 1911.11(b)(3). See also Executive Order 12866, 58 FR 51735 (Sept. 30, 1993) (encouraging administrative agencies to provide a minimum 60 day pre-hearing comment period). The 100 day pre-hearing comment period provided here was more than adequate to meet all of these requirements.

This comment period is also consistent with past OSHA practice in rulemakings of this magnitude. In the Air Contaminants Rulemaking, OSHA proposed to lower the permissible exposure limits for over 400 hazardous substances, 54 FR 2332 (Jan. 19, 1989), an enormous undertaking by any measure. The Eleventh Circuit subsequently rejected a challenge to the 47 day pre-hearing comment period OSHA afforded in that rulemaking. *AFL–CIO* v. *OSHA,* 965 F.2d 962, 969 n.8 (11th Cir. 1992) (Air Contaminants) (''[W]e are unpersuaded that the time period allowed in this rulemaking was so insufficient as to prevent interested parties from commenting on the proposed rule.'').

Numerous other OSHA rulemakings have also included pre-hearing comment periods of similar length. For example:

- Tuberculosis—123 day pre-hearing comment period. 63 FR 5905 (Feb. 5, 1998).
- Butadiene—91 day pre-hearing comment period. 55 FR 42406 (Oct. 19, 1990).
- Bloodborne Pathogens—76 day pre-hearing comment period. 54 FR 23042 (May 30, 1989).
- Hazard Communication—60 day pre-hearing comment period. 48 FR 53280 (Nov. 25, 1983).

Most significantly, it is clear that the 100 day comment period provided the public with an adequate opportunity to comment on the proposed rule. The comprehensive and detailed nature of many of the pre-hearing comments OSHA received is itself compelling evidence of this fact. For example:

- The National Coalition on Ergonomics (NCE) submitted a 156 page comment, as well as attachments of 321 pages. Ex. 30–3956.
- The U.S. Chamber of Commerce (Chamber) submitted a 95 page comment, as well as attachments of 524 pages. Ex. 30–1722.
- Anheuser-Busch, Inc. and United Parcel Service, Inc. (UPS) submitted a 299 page comment, as well as attachments of 2007 pages. These attachments consisted of additional comment and evidence prepared by 23 expert witnesses. Ex. 32–241.
- The Union of Needletrades and Industrial Textile Employees (UNITE) submitted a 70 page comment, as well as attachments of 1078 pages. Ex. 32–198–4.
- The United Food and Commercial Workers Union (UFCW) submitted a 179 page comment, as well as attachments of 2218 pages. Ex. 32–210–2.

Although some of these submissions came from parties complaining that the comment period was inadequate, the comments listed above, as well as many others, demonstrated a thorough mastery of the proposal and preamble, as well as extensive familiarity with OSHA's Preliminary Economic Analysis, its Health Effects discussion, and much of the material in the record. See *e.g.,* Exs. 30–1722; 30–3956; 32–241. And a number of comments were submitted early, including the Chamber's 619 page comment, which was submitted on February 16, 2000, a full two weeks before the due date. See Ex. 30–1722.

Moreover, the pre-hearing comment period represented only one aspect of the public participation opportunities in this rulemaking. OSHA also scheduled nine weeks of informal public hearings and a 90 day post-hearing comment period on the proposed rule. Thus, those parties who filed Notices of Intent to Appear at the hearing had a total of 261 days (nearly nine months) from the date the proposal was issued to the end of the post-hearing comment period to comment on the proposed rule. OSHA believes that this period of time was more than adequate to allow interested parties an opportunity to review the record and submit meaningful comments.

In addition, OSHA's procedures typically provide that only parties who participated in an OSHA rulemaking hearing may file post-hearing submissions. But in this rule OSHA permitted trade associations or other groups who were eligible to file such comments to attach to their own submissions comments from their members who were not eligible to file on their own. Many interested parties (*e.g.,* members of the National Association of Manufacturers) who did not file a Notice of Intent to Appear, therefore, were able to submit post-hearing submissions through their trade association or other group. See *e.g.,* Letters in Ex. 500–1.

Moreover, many interested parties were familiar with the overall structure of the proposed rule before it was published on November 23, 1999. OSHA posted the SBREFA draft, which was similar to the proposed rule in many respects, on its website in February, 1999. Many interested parties, including small business owners, commented on the draft rule. See Ex. 23. In addition, OSHA had engaged interested parties in discussions on ergonomics issues for quite some time before publication of the proposed rule. See Discussion in Part II above. Many parties who commented on the proposed rule and participated in the informal public hearing were very familiar with the issues relevant to the rulemaking long before the pre-hearing comment period began.

For these reasons, OSHA does not agree with those commenters who complained that 100 days was an inadequate amount of time to analyze the rulemaking record fully and to submit meaningful comments on the proposal. A couple of commenters went so far as to claim that the 100 day pre-hearing comment period violated parties' due process rights. Ex. 30–3956, p. 141; 30–3865, pp. 33–4. The American Iron and Steel Institute (AISI) suggested that the OSH Act required OSHA to give a 30 day pre-hearing comment period for each hazard at issue in the rulemaking (*i.e.,* force, repetition, awkward posture, static posture, contact stress, cold temperatures, and vibration); thus, AISI argued that OSHA was obligated to set a 210 day pre-hearing comment period. Ex. 500–223, p. 94. Many commenters noted as well that a number of holidays occurred during the pre-hearing comment period, and that these, as well as Year 2000 computer issues, made review and preparation of comments particularly difficult. See *e.g.,* Ex. 30–3865, p. 34; Letters in Exhibit 33. Finally, a number of commenters stated that OSHA's grant of a 30 day extension of time from 70 days to 100 days was not meaningful because it was not granted until January 27, 2000, a few days before pre-hearing comments were originally scheduled to be filed. See *e.g.,* Exs. 500–188, p. 6 n.3; 500–109; 30–3956, p. 142.

No party's due process rights were violated by the 100 day pre-hearing comment period. As shown above, the comment period was more than adequate for interested parties to review the record and submit pre-hearing comments. Nor does the OSH Act require OSHA to provide a 30 day pre-hearing comment period for each risk factor at issue. As explained above, the OSH Act provides for a minimum 30 day comment period for each ''proposed *rule* promulgating * * * an occupational safety or health standard.'' 29 U.S.C. 655(b)(2) (emphasis added). The OSH Act does not place a requirement upon OSHA to provide additional time for comment depending upon the number or types of hazards being regulated. See Air Contaminants, 965 F.2d at 969 n.8.

Furthermore, the occurrence of holidays during the pre-hearing comment period did not substantially affect the ability of parties to review the record and comment on the proposed rule. In fact, holidays accounted for only five days of the pre-hearing comment period. Similarly, OSHA does not believe that Year 2000 computer conversion issues substantially affected stakeholders' ability to comment on the proposed standard. Employers and other parties always devote resources to different areas of their enterprises at different times of the year. For example, when industry and labor are engaged in collective bargaining negotiations, employers and labor unions (including safety and health representatives) must devote additional resources (including time and money) to the negotiations. The time and resources devoted to these negotiations certainly ''conflict'' with other priorities of both parties. Yet both parties to the negotiations are able to continue to function during this period and to carry out their other responsibilities. These types of conflicts do not prevent interested parties from submitting meaningful comments on any particular proposed rule.

Finally, the extension of the pre-hearing comment period was not granted too late. OSHA originally believed that the 70 day pre-hearing comment period established in the proposal was sufficient to allow interested parties to comment meaningfully on the proposed standard. (The 70 day period was more than twice as long as that required by the OSH Act, and longer than the 60 day minimum period recommended by Executive Order 12866). OSHA seriously considered the requests it received to extend the initial 70 day pre-hearing comment period, however, and ultimately decided to grant the 30 day extension.

OSHA granted the extension on January 27, 2000, a few days before written comments were originally scheduled to be filed. In addition to publishing notice of the extension in the **Federal Register** on February 1, 2000, 65 FR 4795 (Feb. 1, 2000), OSHA issued a press release to inform the public that the comment period had been extended and placed the press release on its web-page. See *http://www.osha.gov/media/oshnews/jan00/national-20000127.html.* Some commenters thanked OSHA for granting the extension. See Exs. 32–21–1, p.9; 500–1–26; 30–4496, p. 1. The 30 day extension was useful in allowing interested parties additional time to review the record and comment on the proposed rule.

In fact, OSHA often grants extensions of comment periods near the end of the original period. For example, in the Butadiene rulemaking, OSHA granted an extension on the final day of the original pre-hearing comment period. 55 FR 42406 (Oct. 19, 1990). Similarly, in the tuberculosis rulemaking, OSHA granted an extension a mere 12 days before the close of the original pre-hearing comment period. 63 FR 5905 (Feb. 5, 1998). Indeed, often it is only toward the end of any filing period that a need to extend becomes clear. It would hardly be logical to permit Agencies to respond to this need only if they did so several weeks before the close of the original comment period.

B. There Was Adequate Opportunity for Participants To Prepare for and Participate in the Informal Public Hearing

1. The Hearing Procedures and the Hearing Schedule

In the November 23, 1999 **Federal Register** notice, OSHA also scheduled an informal public hearing to provide interested parties another opportunity to comment on the proposed standard. 64 FR 65768 (Nov. 23, 1999). Participants in the hearing could present testimony and ask questions of OSHA and other public witnesses. OSHA scheduled the informal public hearing for three cities: Washington, DC; Portland, OR; and Chicago, IL. Id. at 65769. The hearing was originally scheduled to begin on February 22, 2000, and OSHA required participants to file Notices of Intent to Appear by January 24, 2000. *Id.* at 65768. When OSHA extended the pre-hearing comment period, it also delayed the start of the hearing until March 13, 2000, 11 days after the close of the pre-hearing written comment period. 65 FR 4795 (Feb. 1, 2000). In addition, because it received more than 400 Notices of Intent to Appear at the hearing, OSHA added an additional 7 days to the hearing in Washington, DC and Portland, OR, in order to accommodate all members of the public who sought to testify. See 65 FR 11948 (Mar. 7, 2000); 65 FR 19702 (Apr. 12, 2000).

On February 25, 2000, the Assistant Secretary issued special hearing procedures to ensure that the hearing proceeded in a fair, orderly, and timely manner. 65 FR 11948 (Mar. 7, 2000). In doing so, the Assistant Secretary acted pursuant to Section 1911.4 of OSHA's procedural regulations governing informal public hearings, which allows the Assistant Secretary, upon reasonable notice, to specify additional or alternative hearing procedures for good cause. 29 CFR 1911.4. OSHA published the Hearing Procedures in the **Federal Register**, mailed them to every hearing participant, and placed them on its web-page. The Assistant Secretary and the Chief Administrative Law Judge also met with interested members of the public to describe and answer questions about the conduct of the hearing. Representatives of the U.S. Chamber of Commerce, United Parcel Service, Inc., the National Coalition on Ergonomics, and the AFL–CIO attended this meeting.

The Hearing Procedures described the nature of the informal public hearing, as well as the procedural rules governing the hearing. *Id.* The Hearing Procedures gave the locations and scheduled times for the different hearing sites; they also permitted the presiding Administrative Law Judge to extend the hearing past the scheduled closing time for any particular day ''to assure orderly development of the record.'' *Id.*

The Hearing Procedures emphasized that the hearing was a legislative-type hearing, not an adjudicative one. *Id.* Thus, neither the rules of evidence nor other procedural rules governing adjudications applied. *Id.* The hearing was intended to provide an opportunity for persons who filed a Notice of Intent to Appear to testify and question witnesses. *Id.* Such participation, however, was designed to ''facilitate the development of a clear, accurate and complete record, while assuring fairness and due process.'' *Id.* ''The intent is to provide an opportunity for effective oral presentation by interested persons, and to avoid procedures which might unduly impede or protract the rulemaking process * * * '' *Id.* at 11947–48.

The Procedures also described the conduct of the rulemaking hearing. First, a panel of OSHA representatives would be available to answer questions on the proposed standard for two full days, on March 13 and 14, 2000. *Id.* at 11948. The Hearing Procedures explained the process for handling the questioning of the OSHA panel, to assure that the questioning time was distributed in a fair and equitable manner. *Id.* They also prescribed the manner of questioning of OSHA's expert witnesses and a panel of witnesses from the National Institute of Occupational Safety and Health (NIOSH). *Id.*

The Hearing Procedures directed public participants to use their oral presentations to summarize and clarify their written submissions rather than to read those submissions into the record. *Id.* The Procedures provided that the Administrative Law Judge should allocate time for questioning of public witnesses as appropriate; however, the procedures required that the ''testimony and questioning of all witnesses scheduled for each day [be] completed that day.'' *Id.* The Procedures further encouraged participants having similar interests to ''designate one representative [to] conduct the questioning on their behalf.'' *Id.*

Finally, the Hearing Procedures established a 45 day post-hearing period in which participants could submit additional information and data to the record, and a 90-day post-hearing period in which they could submit briefs and arguments on the proposed standard. *Id.*

Along with the Hearing Procedures, OSHA distributed a schedule for witness testimony at the informal public hearing. *See* Ex. 502–476. OSHA sent the initial schedule for the Washington, DC and Chicago, IL locations to hearing participants on February 26, 2000 (with the Hearing Procedures), and posted it on the OSHA web page. OSHA sent the schedule for the Portland, OR location to the Portland participants on March 8, 2000, and also posted it on the OSHA web page. The schedules listed the dates and times for the testimony of the expert witnesses who were to testify on behalf of OSHA, the panel of experts from NIOSH, and each public witness who had filed a Notice of Intent to Appear. *Id.*

The schedule organized the public witnesses into panels, and allotted each witness an amount of time to testify based upon the time the witness had requested. *Id.* The Hearing Procedures established the following format for questioning of the public witnesses: each public witness on a panel would present testimony; after all of the witnesses on the panel presented, the panel as a group would answer questions from members of the public and OSHA. 65 FR 11948–49 (Mar. 7, 2000). The Hearing Procedures, however, also gave the presiding Administrative Law Judge authority to allocate the time for questioning of witnesses in a different manner, as he deemed appropriate. *Id.* at 11949. This provided a fair and orderly process for questioning the public witnesses while allowing flexibility to accommodate participants' desire for more or less questioning of certain witnesses. *See e.g.,* Tr. pp. 9043; 9378–79; 13345.

After OSHA published the initial schedule, a substantial number of participants requested that OSHA alter the hearing schedule. OSHA accommodated these individuals to the extent possible. Some examples of the accommodations made for various hearing participants included:

• American College of Occupational and Environmental Medicine —Rescheduled from 4/13/2000 to 5/11/2000.

• American Iron and Steel Institute—Rescheduled from 4/07/2000 to 4/18/2000.

• American Society of Safety Engineers—Rescheduled from 5/09/2000 to 4/21/2000.

• International Order of the Golden Rule—Rescheduled from 4/07/2000 to 4/12/2000.

• Levi-Strauss—Rescheduled from 4/18/2000 to 5/04/2000.

• National Automobile Dealers Association—Rescheduled from 4/13/2000 to 4/14/2000.

• Association for Suppliers of Printing, Publishing, and Converting Technologies—Rescheduled from 3/31/2000 to 5/09/2000.

• Screenprinting and Graphic Imaging Association International—Rescheduled from 3/22/2000 to 4/12/2000.

• UniSea Inc.—Rescheduled from 4/27/2000 to 5/02/2000.

• Three UPS expert witnesses—Rescheduled from 4/2000 to 5/10/2000.

See Ex. 502–476. Throughout the informal public hearing, OSHA continued to work with hearing participants to try to accommodate their schedules. As OSHA made changes to the hearing schedule, OSHA posted the changes on its web page and often announced them at the beginning or end of a hearing day. *See e.g.,* Tr. pp. 7161; 7567; 13121; 13531.

The informal public hearing began on March 13, 2000 in Washington, DC and ended on May 15, 2000. OSHA's Director of the Safety Standards Program Directorate (Director) made a short statement at the beginning of the hearing. For the rest of the first two days of the hearing, a panel of representatives from OSHA and the Solicitor of Labor (OSHA panel), headed by the Director, answered questions on ergonomics generally and on the proposed standard specifically. In total, the OSHA panel answered questions for approximately 16 hours. *See* Tr. pp. 1–5–819.

As established in the Hearing Procedures, OSHA allowed each member of the public who filed a Notice of Intent to Appear to question the OSHA panel. In order to accommodate the large number of individuals who wished to question the OSHA panel, the Hearing Procedures provided that the questioning occur in ''rounds.'' In total, there were four rounds of questioning of the OSHA panel; thus, questioners were able to question at four different times over the two days. The amount of time allotted for questioners in each round was the following:

• Round 1— Ten minutes per questioner. Tr. p. 1–27.

• Round 2— 20 minutes per questioner. Tr. p. 1–244.

• Round 3— 20 minutes per questioner. Tr. p. 615.

• Round 4— 15 minutes per questioner. Tr. p. 771.

Thus, each member of the public had up to one hour and five minutes to question the OSHA panel.

After the first two days of the hearing, 28 OSHA expert witnesses testified about various aspects of ergonomics, MSDs, and other issues raised by the proposed rule. Ex. 502–476. A panel of representatives from NIOSH also testified about the causes and prevention of ergonomic injuries. *Id.*

The OSHA expert witnesses were grouped into subject-matter panels. Generally, each expert provided affirmative testimony for about 15 minutes (45 minutes per panel), and the panel answered questions for about two hours. In some instances, panels answered questions for approximately three hours. *See e.g.,* Ex. 502–476, Testimony of Wednesday, March 15, 2000; March 20, 2000; March 21, 2000.

During the first two days of testimony by OSHA's experts, the questioning followed the same format as the questioning of the OSHA panel. After the first two days of testimony, however, the Administrative Law Judge altered the allocation of time so that employer representatives collectively, and labor representatives collectively, were each given approximately 40% of the time to ask questions, and OSHA was assigned approximately the remaining 20%. Questioners who did not represent either employers or labor were allotted proportional amounts of time from industry and labor's time. Tr. pp. 1774–75; 1780–1790.

OSHA's expert witnesses testified from Wednesday, March 15, 2000, through Tuesday morning, March 21, 2000. *See* Ex. 502–476. In order to maximize the public's time to question these experts, OSHA encouraged the witnesses to shorten their affirmative presentations, and ceded some of its own time for questioning to industry and labor. *See* Tr. pp. 1791; 1816; 2087; 2496; 2287–88.

A panel of NIOSH experts also testified during the first week of the hearing, on Friday, March 17, 2000. *See* Ex. 502–476. NIOSH was scheduled to appear for 4½ hours, and the public questioners, including both labor and industry representatives, had been allocated 3½ hours for questioning. *See* Ex. 502–476. However, the questioners used only 2 hours and forty-five minutes of this time. *See* Tr. p. 2125.

Public witnesses testified during the remainder of the nine weeks of the informal public hearing. After a panel of public witnesses presented testimony, the witnesses were available for questioning by members of the public and OSHA. *See* Ex. 502–476. The Administrative Law Judge presiding over the hearing on any particular day exercised discretion in terms of how the testimony and questioning of the public witnesses would proceed. On a few occasions the presiding Administrative Law Judge admitted into the rulemaking record evidence and testimony that were not submitted in accordance with the hearing procedures. *See* Tr. pp. 1095–97; 7168–73. Such allowances by the Presiding Officer were appropriate under the hearing procedures in order to ensure a clear, complete, and accurate rulemaking record. With respect to the allocation of time for questioning of the public witnesses, in the vast majority of instances the questioning proceeded in a similar format to that established during the questioning of OSHA's expert witnesses (*i.e.,* dividing the allotted time among industry, labor, and OSHA).

OSHA scheduled appearance times for all of the more than 400 parties who filed Notices of Intent to Appear at the hearing. *Id.* More than 100 of these parties, however, canceled their scheduled testimony. Many of these parties did not notify OSHA of their cancellations, or did so at the last minute, so that OSHA was often not able to adjust the schedule to allow more time for other witnesses. See *e.g.,* Tr. pp. 3138; 9379; 12036–12041.

2. Adequacy of the Procedures

A number of participants complained that the 11 days between the end of the comment period and the beginning of the hearing was too short to allow them to participate meaningfully in the rulemaking. *See* Exs. 500–188, p. 6; 500–197, p. IV–5; 30–3956, p. 142. OSHA disagrees. There is no statutory requirement that OSHA allow any particular amount of time between the close of the comment period and the public hearing. OSHA's own procedural regulations, however, require a 10 day period between the close of the pre-hearing comment period and the hearing. 29 CFR 1911.11(b)(4). The 11-day period OSHA provided in this rulemaking was consistent with those regulations.

During this period, OSHA made unprecedented efforts to assist participants in preparing for the hearing. OSHA extended its Docket Office hours and established a separate ergonomics reading room. See Ex. DC–423. It also made Docket Office staff available to help individuals locate materials quickly and efficiently. Interested parties were able to review the materials submitted to the rulemaking record as soon as they were received by OSHA.

After the schedule for the Washington, DC and Chicago, IL hearing locations was issued on February 26, hearing participants could use it to utilize their own preparation period most effectively. And hearing participants had no need to read each others' comments to prepare for their own questioning of the OSHA panel. Parties had more than 100 days to prepare for this process. In addition, many hearing participants were already familiar with the NIOSH and OSHA expert witnesses and with the substance of their testimony. One of the participants who complained repeatedly that there was inadequate time to prepare for the public hearing had, in fact, cross-examined some of the expert witnesses on similar issues in earlier OSHA enforcement litigation. See Attachments to Ex. 30–1722. OSHA therefore disagrees with those commenters who stated that 11 days was insufficient to review the comments and testimony submitted, or to prepare for questioning of all of the witnesses who were scheduled to appear over the nine weeks of hearings. See Exs. 500–188, p. 6; 500–197, p. IV–5; 30–3956, p. 142.

The conduct of the hearing was also consistent with the OSH Act and OSHA's procedural regulations. Although this legislative type hearing is informal, OSHA's procedural regulations provide for more than the bare essentials of informal rulemaking and include: (1) An ALJ to preside at the hearing; (2) ''an *opportunity* for cross-examination on *crucial issues*,'' and (3) a verbatim transcript of the hearing. 29 CFR 1911.15(b) (emphasis added). Indeed, OSHA rulemakings differ from the rulemakings of other federal agencies in that members of the public can question OSHA's expert witnesses and each other. The procedural regulations also permit the Assistant Secretary for OSHA, upon reasonable notice, to ''prescribe additional or alternative procedural requirements:

- In order to expedite the conduct of the proceeding;
- In order to provide greater protection to interested persons whenever it is found necessary or appropriate to do so; or
- For any other good cause which may be consistent with the applicable laws.''

See 29 CFR 1911.4.

Here, as it frequently does, OSHA scheduled the informal public hearing when it published the proposed rule on November 23, 1999. The informal public hearing complied with OSHA's procedural regulations: (1) An Administrative Law Judge presided over it; (2) interested parties were given an opportunity to cross-examine witnesses on crucial issues; (3) OSHA provided transcripts of the proceedings; and (4) OSHA designed procedures that effectuated the stated intent of OSHA informal hearings, *i.e.,* ''to provide an opportunity for effective oral presentation by interested persons which can be carried out with expedition. * * *'' 29 CFR 1911.15(a)(3).

Due to the large number of individuals who filed Notices of Intent to Appear, the Assistant Secretary also had ''good cause'' to issue special hearing procedures to ensure that the hearing proceeded in a fair and orderly manner. The Assistant Secretary issued the Hearing Procedures on February 25, 2000, giving hearing participants reasonable notice. OSHA mailed the Hearing Procedures the very next day to all individuals who had filed Notices of Intent to Appear, published them in the **Federal Register**, and posted them on the OSHA web page. In addition, the Assistant Secretary and the Chief Administrative Law Judge held a meeting with interested parties on March 7, 2000, in order to discuss the procedures and answer any questions from the participants.

The conduct of the informal hearing was also consistent with that of other OSHA rulemakings. For example, in the Tuberculosis rulemaking, the Pre-hearing Guidelines signed by the Administrative Law Judge laid out the following similar parameters:

- The purpose of the hearing was for information gathering and clarification; the hearing was not an adjudicative one but rather an informal administrative proceeding.
- Each hearing day would end when the scheduled testimony and questions for the day had been completed.
- Because written submissions were made a part of the rulemaking record, public witnesses ''should'' use their oral testimony to summarize and clarify their written submissions.
- Questioning of public witnesses should be limited to 15 minutes, but the presiding Administrative Law Judge could alter the schedule as appropriate to allow more time for questioning of a particular witness.
- If the hearing were to fall significantly behind schedule, the presiding Administrative Law Judge could further restrict the questioning or order further consolidation of the questioning.
- Participants having similar interests should, if possible, designate one representative to conduct the questioning on their behalf.
- If an organization were represented by more than one questioner, only one person should question a witness on a particular topic area.
- Questions should be brief and should be designed to clarify a presentation or elicit information within the competence or expertise of the witness.
- A tentative 120 day post-hearing comment period was established.

Docket H–371, Ex. 24; *See also* Pre-hearing Guidelines for Hearing on Employer Payment for Personal Protective Equipment, Docket S–042, Ex. 17 (including same); Mintz, *OSHA: History, Law, and Policy* 66–7 (BNA 1984). As is clear from the above, OSHA did not deviate meaningfully in the ergonomics rulemaking hearing from the hearing procedures used in past OSHA rulemakings.

For these reasons, OSHA does not agree with those commenters who stated that the informal public hearing was not adequate to provide interested parties an opportunity to present additional evidence, and to cross-examine public witnesses and OSHA on crucial issues. *See* Exs. 500–188, pp. 6–10; 500–197, pp. IV–11–14. On the contrary, OSHA believes that the process struck an appropriate balance: it gave interested parties the opportunity to present testimony, to question OSHA, and to question other members of the public, while ensuring that the proceedings would proceed in an orderly manner.

Specific objections included the complaints of some participants that they did not have enough time to question the OSHA panel and that OSHA did not disclose who would be representing it on the panel until the day the informal public hearing began. *See e.g.,* Tr. pp. 1–42–43. A few of these commenters, United Parcel Service, Inc., the National Coalition on Ergonomics, and the U.S. Chamber of Commerce, requested that the OSHA panel return for additional questioning at the end of the informal public hearing. Ex. DC–424. Before the Assistant Secretary could respond to that request, however, it was modified (and presumably withdrawn) on April 11, 2000. *Id.; see also* Tr. pp. 17956–58.

In any event, OSHA believes that the hearing participants had more than an adequate opportunity to question the OSHA panel on the proposed rule. The OSHA panel answered questions for approximately 16 hours; those participants who questioned the panel for each round had over one hour to question the panel.

Like other administrative agencies, OSHA explains its reasons for issuing a proposed rule in the preamble to the proposal and other supporting documentation. OSHA is not required by any law or regulation to explain its rationale further at the informal public hearing. OSHA, however, generally spends some time at the beginning of rulemaking hearings answering a few questions from participants. In the past, OSHA usually made a panel available for a few hours at the beginning of the hearing. For example, in both the Tuberculosis and Access to Employee Exposure to Medical Records hearings, the OSHA panel answered questions for a couple of hours at the beginning of the hearings. *See* Docket H–022B, Ex. 171A; Docket H–371, Ex. 25A. Recognizing that there were a number of parties who wished to question the Agency more extensively in this case, however, OSHA deviated from its past practice and set aside two full days for the panel to answer questions on the proposal. *See* Ex. 502–476.

Furthermore, in order to ensure that the questioning was evenly distributed among the participants, OSHA set up a format for the questioning. OSHA established several ''rounds'' of questioning. Although there were a large number of individuals who wished to question OSHA during the first two rounds, only a few had remaining questions in rounds three and four. In fact, by the final round of questioning only three questioners (representing Boral Bricks, NCE, and the Chamber) asked questions of OSHA. Tr. pp. 771–819. Those parties who utilized their full time in every round had over one hour total to question OSHA. OSHA believes that this schedule provided adequate time for interested parties to question the Agency, while not unduly protracting the rulemaking process.

Finally, OSHA did not prejudice any member of the public by waiting until the day of the hearing to disclose the members of the OSHA panel. The purpose of the first two days of the informal public hearing was to allow interested parties an opportunity to question OSHA about its proposed rule; the purpose was not to provide an opportunity to question individuals about their views of the proposed rule. The panel members were made available to answer questions about the proposed rule on behalf of OSHA. They did not appear to express personal opinions about ergonomics or the proposed standard. Thus, there is no validity to the implication that questioners should have had additional time to prepare for the kind of credibility-based cross examination that would be appropriate in adversarial litigation. *See e.g.,* Tr. pp. 539–41.

Some participants also objected during the hearing that there was not enough time to question the government's expert witnesses. Tr. pp. 936–941; 1438–1444. The Chamber, for example, complained that OSHA only gave ''industry as a whole under two hours of cross-examination'' to question the NIOSH panel. Ex. 500–188, p. 7 (emphasis in original).

Once again, OSHA believes that the amount of time allotted for questioning its expert witnesses was reasonable and provided interested parties adequate time to ask questions, clarify presentations, and elicit new information, while not unduly protracting the rulemaking process. Each panel was available for questioning for over two hours (and on many occasions for over three hours).

See Ex. 502–476. This amount of time was longer than that provided for questioning of most other members of the public, and OSHA believes it was sufficient to allow members of the public to question the experts on ''crucial issues.''

OSHA also encouraged its expert witnesses to provide only brief oral presentations. Some of them gave only short opening statements. *See e.g.,* Tr. pp. 2361–65, 2366–69, 2369–72; *see also* Tr. pp. 1816 (Industry questioner thanking panel of OSHA expert witnesses for abbreviating testimony). On other occasions, OSHA ceded the Agency's time to the public for questioning. *See e.g.,* Tr. pp. 2087; 2496; 2287–88. Contrary to the arguments of UPS and NCE that the procedures were somehow designed to ''minimize time available for industry questioning,'' Ex. 500–197. p. IV–13, OSHA's efforts in fact *increased* the amount of time for public questioning of the expert witnesses.

Third, the Administrative Law Judge changed the questioning format after the second day of testimony by the government experts in order to allow questioning to proceed more efficiently. To ensure an even distribution of questioning, the Administrative Law Judge divided the time available for questioning among the three broad categories of questioners—labor, industry, and OSHA. The Hearing Procedures issued by the Assistant Secretary gave the Administrative Law Judge this authority; in fact, the Procedures envisioned the exercise of this authority in just such a situation. See 65 FR 11948 (Mar. 7, 2000). OSHA believes that this revision in format allowed all interested participants an even greater opportunity to question OSHA's expert witnesses.

Finally, OSHA finds completely unfounded the allegation made repeatedly by some commenters (including the Chamber) that there was insufficient time to question the NIOSH panel. *See e.g.,* Ex. 500–188, p. 7. OSHA allotted an entire afternoon, 3½ hours, for questioning of the NIOSH panel. (In total, OSHA scheduled NIOSH for a 4½ hour block of time to present its testimony and respond to questions.) In fact, the hearing was recessed early on that day because there were no questions left for the NIOSH panel to answer. *See* Tr. p. 2125. The time allotted for questioning of the NIOSH panel was more than adequate; if anything, OSHA scheduled too much time for the questioning of this panel.

OSHA also believes that all interested parties had an adequate opportunity to present their affirmative testimony. *See e.g.,* Tr. pp. 16851–52. First, as OSHA stated in its Hearing Procedures, public witnesses were asked to summarize their written submissions. See 65 FR 11948–49 (Mar. 7, 2000). Because written submissions were already part of the rulemaking record and available for all to review beforehand, there was no reason for participants also to read those submissions into the record.

Second, OSHA established the amount of time for public testimony based on the amount of time witnesses requested in their Notices of Intent to Appear. Witnesses who requested only 10 minutes to testify were typically scheduled for the entire amount of time they requested in their Notice. If individuals requested 15 minutes, OSHA typically scheduled them for 10 minutes of affirmative testimony. If they requested 20 minutes, OSHA typically scheduled them for 15 minutes. For witnesses who requested longer periods of time, OSHA scheduled time for affirmative testimony based upon the number of topics to be addressed by a hearing participant. Thus, UPS filed Notices of Intent to Appear for over 20 individuals and requested varying amounts of time to cover a wide range of subject areas. Ex. 32–241–1. OSHA allotted these witnesses 2½ days (22 hours and forty-five minutes), a significant amount of time by any measure, to present their testimony and respond to questions. Ex. 502–476. OSHA believes that the amount of time given the public witnesses to testify met the goal of allowing interested parties to summarize their main points, while not ''unduly protracting'' the rulemaking process.

Nonetheless, some participants objected throughout the hearing that there was not enough time to question public witnesses. *See* Tr. pp. 8265; 3500; 6062. NCE *et al.,* for example, stated that OSHA improperly ''suspended the rules that allow for [cross-examination]'' and asked leading questions of certain witnesses in a manner that did not develop the rulemaking record. Ex. 500–197, p. IV–11, 15–16.

OSHA did not suspend any rules allowing for cross-examination. In fact, as described in detail above, the hearing procedures expressly provided for cross-examination. The hearing was not a trial, however, and no OSHA procedural regulation gives the public unlimited time to question witnesses. The public's desire to question witnesses must be balanced against the primary function of the hearing: to assist OSHA in gathering evidence that will help the Agency determine whether and how to regulate. Those parties who complained that their ability to ''cross-examine'' certain witnesses was improperly curtailed misunderstood the nature and purpose of OSHA's informal rulemaking hearings.

It is clear that the public witnesses had adequate time to question each other. The schedule typically allowed a panel of witnesses to be questioned for one hour. In other words, for every hour of testimony, OSHA allowed an hour of questioning. Consistent with its decision to allow much more time for questioning of the government expert witnesses, OSHA also allowed for greater questioning of public witnesses who were particularly well-known in the field of ergonomics.

- Dr. Don Chaffin, a Professor of Industrial Engineering at the University of Michigan, former Director of its Center for Ergonomic Studies, and author of numerous articles on ergonomics (*See* Ex. 500–5), appeared on a panel by himself and had only a short affirmative presentation; OSHA ceded its own questioning time to allow for more questions from the public. Tr. p. 8264.
- Dr. Gary Franklin, a physician who treats patients with MSDs and has written extensively on ergonomics and MSDs, appeared on a panel by himself and only gave a short affirmative presentation; the amount of time available for questioning by industry representative was significantly increased by the presiding Administrative Law Judge. *See* Tr. pp. 13340–13415.
- Dr. Barbara Silverstein, Director of the Safety and Health Assessment and Research Program in Washington State and author of numerous articles on ergonomics and MSDs, appeared on a panel with one other individual and had only a short affirmative presentation; members of the public had one hour to question the two witnesses. *See* Ex. 502–476.

Second, OSHA repeatedly ceded to the public its own questioning time to allow for more questioning by public participants. *See e.g.,* Tr. pp. 8264; 10546; 17602–03. The Administrative Law Judges also often adjusted the schedule to allow more time for questioning of witnesses when interested members of the public had remaining questions. *See e.g.,* Tr. pp. 8263–66; 13345; 13366; 13380; 13415.

The time available for questioning could have been substantially increased had more scheduled witnesses notified OSHA in advance of their intent not to appear. As stated above, over 100 witnesses canceled their appearances (amounting to approximately one week of scheduled hearing time), often with no advance notice. This included many of the same parties who objected most vigorously to the length of the questioning time and would have been expected to be most anxious to assist OSHA in increasing that time. *See e.g.,* Tr. pp. 3138; 12036–12041. For example, UPS and its expert witnesses requested over 20 hours to present affirmative testimony. OSHA scheduled almost 23 hours for UPS testimony and questioning. UPS, however, canceled all but six of those witnesses. OSHA was unable to fill that time; this resulted in approximately two days during the hearing where no testimony or questioning occurred. *See* Ex. 502–476. Similarly:

• Keller & Heckman LLP requested 40 minutes to testify and canceled its appearance. *See* Exs. 32–215; 32–215–1.

• Fed Ex Corporation and its subsidiaries requested 100 minutes to testify and canceled their appearances. *See* Exs. 32–203; 32–205; 32–208; 32–209; 32–208–2.

• NCE's economic task force requested 130 minutes to testify and canceled its appearance. *See* Ex. 32–375; Tr. pp. 12036–41.

• The Rubber Manufacturers Association requested 45 minutes to testify and canceled its appearance. *See* Ex. 32–242; Tr. p. 3138.

All of these entities, or representatives of these entities, objected to the amount of time allotted for cross-examination of witnesses. See Ex. 500–197 section IV; Tr. p. 2303.

NCE *et al.*contended that OSHA further reduced the time for the public questioning of witnesses by using its own questioning time ineffectively. Ex. 500–197, IV–14–15. But many participants in the hearing complained that others asked irrelevant questions, wasted time, and otherwise failed to develop the record efficiently. The AFL–CIO pointed to an exchange in which a UPS lawyer spent several transcript pages attempting, unsuccessfully, to elicit a particular response from an AFL–CIO witness. Ex. 500–218, pp. 168–170. But this merely highlights that one participant in a rulemaking may believe that certain questions are of relevance, while another participant may think precisely the opposite. OSHA designed the informal public hearing to give both itself and the hearing participants the opportunity to question members of the public in a manner each believed would best develop the rulemaking record. OSHA believes that it did this effectively throughout the informal hearing.

The same participants also complained that ''OSHA withheld the hearing transcript from the rulemaking's participants'' and that the ''transcripts were not provided until the hearings were ended.'' Ex. 500–197, p. IV–17; see also Ex. 500–109. However, OSHA did not withhold the transcripts from the hearing participants; nor did OSHA wait until the end of the proceedings to make the transcripts available. First, during the initial week of the hearing, OSHA informed participants that they could contact the reporter directly to receive copies of the hearing transcripts. Tr. p. 936. Second, on May 3, 2000, OSHA placed on its web page unofficial copies of the hearing transcripts. Third, on May 30, 2000, OSHA made the official transcripts available on its web-page. OSHA placed paper copies of the official transcripts in the Docket Office a few days later.

There is no statutory, regulatory, or other authority requiring that OSHA go to such lengths to provide copies of the transcripts to the public. OSHA's procedural regulations state only that transcripts ''shall be available to any interested person upon such terms as the presiding officer may provide.'' *See* 29 CFR 1911.15(b)(3). OSHA's efforts to make the transcripts available certainly exceeded what is required by its procedural regulations and was more than adequate to allow parties to review transcripts of the proceedings promptly and in a meaningful way.

C. Availability of Record Material in the Docket

When it issued the proposal, OSHA placed in the rulemaking docket a large amount of material and evidence. Throughout the rulemaking, OSHA received additional evidence, both from rulemaking participants and through its own efforts. This entire body of evidence forms the basis for the issuance of this final standard, and OSHA took unprecedented steps to ensure that all of it was available for public inspection.

The OSHA Docket Office (Docket Office) provides a number of ways to review and access materials submitted. First and foremost, the Docket Office maintains hard copies of all documents submitted to the rulemaking record and places them on a central shelf in the Docket Office reading room. Any interested party can view and copy these documents, consistent with applicable copyright laws. Docket Office staff are always available to help interested parties find and obtain rulemaking materials. Until recently, this method was the only way to access an OSHA rulemaking docket.

Recently, however, OSHA has been exploring methods of using technology to make access to its dockets even more convenient. For example, OSHA began a process of scanning all materials into an electronic database. This permits interested parties to view documents in the database, search for documents submitted, and print copies of the documents. OSHA intends this system to provide an easier means to view materials submitted to its rulemaking records.

Because OSHA anticipated that there would be a large amount of material submitted to the docket during this rulemaking, the Agency implemented special procedures to ensure timely and convenient access to the docket. For example, OSHA made the proposed rule and preamble, the Preliminary Economic Analysis, and the full Health Effects sections available on its web page and on CD–ROM. In fact, OSHA mailed a CD–ROM containing this information free of charge to all parties who participated in the stakeholder meetings OSHA held before issuance of the proposed rule and to any other interested party upon request.

OSHA also extended its Docket Office hours by 3 hours a day, and designated an area in the Docket Office as an ''ergonomics reading room,'' where parties could review docket submissions as soon as they were received by the Agency. Ex. DC–423. In addition, OSHA moved people from other positions in the Agency to process public comments and scan the material into the computer database as quickly as possible. These steps, which exceeded any legal obligations and went far beyond OSHA's own past practice, were more than adequate to ensure interested parties a meaningful opportunity to comment on the proposed rule.

Although an administrative agency engaged in rulemaking must make ''critical factual material * * * used to support the agency's position'' available to the public for review in a rulemaking proceeding, *Air Transport Ass'n.* v. *FAA*, 169 F.3d 1, 7 (D.C. Cir. 1999), agencies generally are not required to make the material ''available'' in any particular format, so long as the public has an opportunity to review the material during the rulemaking.

There can be no question that OSHA made the material ''available'' here within the meaning of this requirement. With only a few exceptions, OSHA placed all documents cited in the preamble to the Proposal in the Docket Office by November 23, 1999—the date the proposal was published. OSHA also scanned the documents into a computer database to allow interested parties to view, search, and print copies of the documents more efficiently. Docket Office staff were available to help interested parties in searching the computer database and locating particular documents. See Ex. 30–3956, p. 133 (''[T]he Docket Office staff were extraordinarily helpful in attempting to assist us in gaining access to OSHA's data, even to the extent of allowing us a dedicated work station in the docket office (subject, of course, to use by OSHA staff in carrying out their projects).''). But OSHA did not design the database to serve as the primary mechanism for reviewing the rulemaking record; it is an additional convenience for the public.

In fact the computer database for viewing, searching, and printing the record is relatively new technology in the context of OSHA's rulemakings. Similarly, OSHA has not previously made documents available on CD–ROM and the web page. Extending the hours the Docket Office was open to allow the public greater access to the rulemaking record was also not commonplace in earlier rulemakings; the Agency also does not typically dedicate a special area of the Docket Office to serve as a reading room. Thus, in numerous earlier rulemakings, interested parties reviewed and copied (as necessary) the paper copies of documents submitted to the record of a particular rulemaking. The extraordinary efforts made in this case not only exceeded any applicable legal requirements, they were an appropriate response to the comments of some parties that the number of issues involved in the rulemaking required additional accommodations. *See e.g.,* Ex. 500–223, p. 94.

For these reasons, OSHA does not agree with those commenters who contended that underlying record material was not available to interested parties for their review. NCE, for example, alleged that ''numerous documents were missing or unavailable because they had been sent out for photocopying, including the 1100 page Preliminary Economic and Regulatory Flexibility analysis and approximately 500 pages of associated materials offered in support of the Agency's conclusions,'' Ex. 30–3956, p. 133, and that Exhibits 28–3, 28–4, 28–5, and 28–6 were not available for review on November 23, 1999. Ex. 30–3956, Appendix IV. NCE also made a number of other attacks on the integrity of the record and on OSHA's provision of access to it:

- OSHA generally relied upon additional underlying data that it did not make available to the public.
- There was only one high speed printer for use in the OSHA docket office, and that printer takes approximately two hours to print 800 pages.
- The Docket Office only stays open for 6 hours a day.
- The computer systems and printers were not operating perfectly—there were occasional computer and printer failures.
- OSHA rejected a request for electronic copies of the entire docket on disk or zip drive, even though the docket was available to OSHA staff through its intranet.
- The copying fee of 15 cents a page was excessive.
- OSHA relied on a NIOSH review of 2000 studies in supporting the proposed rule; ''the 2000 studies were not'' in the docket.
- One economic document appeared to be named differently in the Preliminary Economic Analysis than in the preamble.
- The Docket Index was incomplete at certain times during the pre-hearing comment period.
- Only the cover pages of some documents were in the docket, as compared to the entire document.

Ex. 30–3956, pp. 134–37.

Many of these allegations are not accurate, and those that are represent the minor and harmless complications of managing any large record. It is not true that ''numerous'' documents, including the Preliminary Economic Analysis, were not available for public inspection by November 23, 1999. The Preliminary Economic Analysis was stamped as received in the Docket Office at 9:55 a.m. on November 23, 1999. As such, it was available for inspection and copying at that time. To the extent interested parties had difficulty locating or obtaining the Preliminary Economic Analysis, Docket Office staff were available to assist them.

OSHA also disputes the allegation that Exhibits 28–3, 28–4, and 28–5 were missing on November 23, 1999. In fact, the record indicates that Exhibits 28–3 and 28–4 were entered into the computer database on November 23, 1999 and thus were certainly available for viewing at that time. Exhibit 28–5 is a number without an exhibit; there is no such document and ''Exhibit 28–5'' was not cited or relied upon by OSHA in the preamble to the proposed rule, or in the Preliminary Economic Analysis.

OSHA does not know which other documents NCE and other commenters, *see* 30–3815, p. 4; 30–3956, pp. 133, 135; 30–3819, p. 3, claim were ''unavailable.'' After the proposed rule was published, however, OSHA discovered that a few documents cited in the proposed rule had been inadvertently omitted from the material placed in the docket by November 23, 1999. These documents included the following:

- *Firm Size Data Provided by the Bureau of the Census (Exhibit 28–6)*—These data provide estimates of the number of firms, number of establishments, employment, annual payroll and estimated receipts for employment size of firm categories by SIC code. It is available to the public from the Small Business Administration web page. OSHA used this information to estimate the economic impact of the proposed rule on various industries, as well as small businesses. When OSHA recognized that these data had inadvertently not been placed in the docket, it immediately placed in the docket a hard copy of the web page where interested parties could access the material (on December 23, 1999). On February 1, 2000, OSHA placed hard copies of the data (127 pages) in the docket. *See* Ex. 28–6–1.
- *RMA data*—These data provide net return on sales information by industry SIC code and are available in many public libraries. OSHA used this information to estimate the economic impact of the proposed rule on various industries. Due to copyright concerns, OSHA originally did not place this information in the docket. OSHA later obtained permission to include these data in the docket; once it obtained this permission, OSHA placed the information in the docket (on February 18, 2000). *See* Ex. 28–10.
- *IRS data*—These data also provide net return on sales information by industry and are available on the IRS web page. OSHA only used these data for a handful of industry sectors for which the RMA data were not available. When OSHA recognized that these data had inadvertently not been placed in the docket, it immediately placed the material in the docket (on January 31, 2000). See Ex. 28–9.

OSHA also did not rely upon data that it did not place in the rulemaking record. The commenters who raised this issue did not identify precisely what data they were referring to, *see* Exs. 30–3716, p.5; 30–3736, p. 10, but it may have been the same material that was requested in a number of Freedom of Information Act (FOIA) requests filed by some hearing participants. *See e.g.,* Ex. 503. Some of these requests were for information that was in the rulemaking docket, and others were for information that was not part of the rulemaking record, because OSHA had not relied on it in the proposed rule.

OSHA responded to the requests for information in a timely manner. *See* Ex. 500–23–1, p. 8. To the extent the information was available, OSHA provided it to the requesters, and, as appropriate, placed the FOIA requests and responses in the docket. *See* Ex. 503. OSHA is not, however, aware of any information it relied upon that it did not place in the docket. To be sure, OSHA receives data and information from a number of different sources when preparing a proposed rule. But all data that were relevant to the promulgation of the proposed rule and were relied upon by OSHA in the rulemaking were placed in the record.

The allegation that ''2000 studies'' relied upon by NIOSH in its literature review were not in the docket on November 23, 1999 is also factually inaccurate and of questionable relevance. NIOSH did not rely on 2000 studies in its literature review. As described more fully in Section V above, NIOSH originally examined 2000 studies in preparing its literature review but chose to use only about one-third of them, based on certain methodological criteria NIOSH established for the study. Ultimately, NIOSH included about 600 studies in its literature review. Many of these studies were in the rulemaking docket. For example, a quick check by OSHA located the following studies in the rulemaking record:

• Aaras A. [1994]. Relationship between trapezius load and the incidence of musculoskeletal illness in the neck and shoulder. Int. J. Ind. Ergonomics 14(4):341–348. Ex. 26–892.

• Armstrong T. *et al.* [1987a]. Ergonomic considerations in hand and wrist tendinitis. J. Hand. Sur. 12A(5):830–837. Ex. 26–48.

• Bigos S. *et al.* [1986b]. Back injuries in industry: a retrospective study. III. Employee-related factors. Spine 11:252–256. Ex. 26–871.

• Dehlin O. [1977]. Back symptoms and psychological perception of work: a study among nursing aides in a geriatric hospital. Scand. J. Rehabil. Med. 9:61–65. Ex. 26–820.

Even though a few of the studies examined by NIOSH may not have been in the docket, however, the public would not have been deprived of an adequate opportunity to review the information OSHA relied upon in the proposed rule, because OSHA relied upon the NIOSH literature review in discussing the epidemiological evidence supporting the proposed standard. The NIOSH literature review was in the docket and available for review by November 23, 1999. Ex. 26–1. OSHA's use of, and reliance upon, its research arm in this manner was expressly contemplated by Congress when it created NIOSH in the OSH Act. *See* 29 U.S.C. § 671. Furthermore, OSHA is not obligated to place in the docket every underlying study used by any researcher in reviewing the scientific literature about any particular subject. *Cf. Cable & Wireless P.L.C.* v. *FCC*, 166 F.3d 1224, 1234 (D.C. Cir. 1999) (FCC did not unreasonably rely upon published study even though underlying data for the study was not available to the FCC or the public).

It is also not true that printer failures and other computer problems prevented interested parties from reviewing and commenting meaningfully on any material in the docket. As stated earlier, OSHA is required to make critical material available for public inspection during the rulemaking proceeding. OSHA is generally not required to make such material available in any particular form or manner. In this case, OSHA made the relevant material available in hard copy format for review and copying (as appropriate) in the Docket Office reading room. OSHA is aware of no commenter who has suggested that any of the material in the docket was not available in hard copy form or that any of the copying machines were not functioning during the comment period. Indeed, one commenter expressly noted that there were ''no particular difficulties'' in requesting, reviewing, and copying documents in the rulemaking record. Ex. 500–218, p. 165.

And as explained, OSHA never intended its computer database to serve as the sole method for interested parties to use to review the record. OSHA intended the database to be an additional tool to facilitate this review, for those participants who prefer electronic access. OSHA does not believe that the occasional technical failure of this additional tool deprived any party of an opportunity to review relevant material.

Similarly, interested parties were not denied meaningful review because OSHA did not produce the entire docket electronically or on a zip file. First, as described above, OSHA provided a number of documents to interested parties on its web page and on CD–ROM, including the full Health Effects section as well as the entire Preliminary Economic Analysis. Second, OSHA made the information in the docket available electronically on its computer database. Providing the entire docket on a zip file would have been administratively difficult, expensive, and time consuming, particularly since the docket was constantly growing, with new submissions being received by Docket Office staff daily.

Third, providing the record in such a way would raise copyright issues for some of the material in the record. Finally, and as mentioned previously, OSHA is not required to provide the material in the record as an electronic or zip file. OSHA is, of course, continually investigating new ways to provide interested members of the public with access to the rulemaking record. However, there is surely no due process requirement that OSHA provide access to the document in any particular form, and OSHA's decision not to provide an additional form of electronic access did not violate due process or impede participants' ability to view the material in the rulemaking.

The fact that the Docket Office was open for 6 hours a day during the prehearing comment period also did not deny any party an adequate opportunity to review the record. Particularly with the technological assistance described above, OSHA believes that interested parties could adequately review the record and comment on the proposed rule in the time allotted. And as also discussed above, the quality and comprehensiveness of the pre-hearing submissions, including NCE's own 156 page submission, belie any suggestion that the parties were impeded in their ability to comment. Even so, when the hearing began OSHA extended the Docket Office hours to allow the public even more time to review the comments and evidence received into the rulemaking record. Docket Office hours were extended on March 13, 2000; the Docket Office continued these extended hours until September 1, 2000, well after the rulemaking record closed.

Certainly, the $0.15 a page fee the Docket Office charges for copying and printing did not deny interested parties an opportunity to review the record. OSHA is authorized to charge this nominal fee in order to recoup some of the costs of paper and toner, etc. *See* 29 CFR 70.40(d)(2). But OSHA does not charge any fee for interested parties to enter the Docket Office and review documents submitted to the record, so the fee did not prevent any interested party from viewing any document.

The fact that one particular economic document was improperly named in the Preliminary Economic Analysis also did not deprive parties of an adequate review of the record. Certainly, OSHA took pains to ensure that all documents were accurately cited in the preamble to the proposed rule, as well as in the computer database. It is precisely because human error may occur from time to time, however, that Docket Office staff are available to answer questions from interested parties, as well as to make inquiries of OSHA if parties are having difficulty locating certain documents. The specific document referred to by NCE, *Exhibit 28–7—Tabulations from OSHA's 1993 Ergonomics Survey*, was inadvertently titled *Description of Cost Estimates of Ergonomic Controls Under Draft OSHA Ergonomics Standard* in both the Preliminary Economic Analysis and the Summary of the Preliminary Economic Analysis (Summary) in the Preamble. OSHA corrected the error in the Summary in a corrections notice published December 30, 1999. See 64 FR 73448–58 (Dec. 30, 1999). OSHA, however, did not place any new material—material that would have required additional analysis—into Exhibit 28–7 after correcting the title to the document. OSHA thus does not believe that this inaccurate citation deprived the public of an opportunity to review and comment upon the material in the Exhibit.

OSHA also believes that the Docket Index was never ''incomplete.'' By its very nature, the Docket Index is an unfinished and ever-growing document. Interested parties are continually sending documents to OSHA to place in the record. When the Docket Office receives a document, it is processed and placed into the record. Part of the processing involves entering the document into the computer database and generating the Docket Index. Thus, the Docket Index is constantly growing as new information is submitted to the record. This does not mean, however, that the Docket Index is ''incomplete'' at any particular time.

Docket Office staff processed rulemaking documents as soon as possible upon receipt. Indeed, OSHA moved people from other positions within the agency to expedite this process. OSHA does not believe that its processing of documents into the record and onto a Docket Index deprived any interested party an adequate opportunity to review the record or to comment meaningfully on the proposed standard.

Finally, in a few cases, due to copyright concerns, OSHA placed only the cover pages and tables of contents of published documents into the docket. These documents were generally available to interested parties upon request; they were also often publicly available. *See e.g.*, Tr. p. 2640 (Hearing participant complaining that only cover page of book in the record, but admitting he was able to obtain copy of the book). Once again, Docket Office staff were available to answer any questions from interested parties and to help locate materials that might otherwise be difficult to find. OSHA does not believe that this practice deprived interested parties of their right to review the record.

As the above discussion demonstrates, OSHA undertook extraordinary measures to provide interested members of the public access to the rulemaking record. These efforts ensured that all participants had an opportunity to examine the underlying information and comment meaningfully on the proposed rule.

D. OSHA's Use of Expert Witnesses

Consistent with its past practice, *see* Mintz, *OSHA: History, Law, and Policy* 64–5 (BNA 1984), OSHA contracted with a number of experts to testify at the hearing and to provide other assistance in the rulemaking process. Twenty-eight experts prepared pre-hearing comments, testified during the informal public hearing, answered questions at the hearing, and submitted post-hearing comments and data. These experts testified on a wide range of issues including the work-relatedness of MSDs, the diagnosis of MSDs, the implementation of engineering controls in workplaces, and the costs of ergonomic programs. *See* Testimony in Ex. 37. OSHA's use of expert witnesses in this way is expressly authorized by the OSH Act, is consistent with past practice, and is consistent with the practice of other administrative agencies.

Section 7(c)(2) of the OSH Act states: ''In carrying out his responsibilities under this Act, the Secretary [of Labor] is authorized to * * * (2) employ experts and consultants or organizations thereof as authorized by Section 3109 of Title 5.'' 29 U.S.C. § 656(2). The OSH Act does not limit the purposes for which OSHA may obtain expert assistance, and assuring that it has appropriate expertise during rulemaking proceedings falls squarely within this authorization. In *United Steelworkers of America* v. *Marshall (Lead)*, 647 F.2d 1189 (D.C. Cir. 1980), the U.S. Court of Appeals for the District of Columbia Circuit upheld OSHA's authority under the OSH Act to employ experts to prepare written comments, submit relevant data, and present testimony during rulemaking proceedings. The court stated: ''The OSH[] Act empowers the agency to employ expert consultants * * * and OSHA might have possessed that power even without express statutory authority * * * .'' *Id.* at 1217. The court also noted that it would be absurd to require OSHA and other agencies to ''hire enormous regular staffs versed in all conceivable technological issues, rather than use their appropriations to hire specific consultants for specific problems.'' *Id.*

OSHA has historically used experts to testify at public hearings about parts of proposed rules that fall within their areas of expertise. Some earlier OSHA rulemakings that involved OSHA expert witnesses included: the Lead rulemaking (1980); the Hazard Communication rulemaking (1983); the Ethylene Oxide rulemaking (1984); the Benzene rulemaking (1987); and the Methylene Chloride rulemaking (1997). Other federal agencies also use expert witnesses in ways similar to OSHA's. The Environmental Protection Agency, the Food and Drug Administration, and the Department of Transportation, for example, make extensive use of consultants in their rulemaking activities. See e.g., *BASF Wyandotte Corp.* v. *Costle*, 598 F.2d 637, 640–41 (1st Cir. 1979) (EPA retained outside consultants to analyze pesticide industry in preparation of regulation); *cf. National Small Shipments Traffic Conf., Inc.* v. *I.C.C.*, 725 F.2d 1442, 1449 (D.C. Cir. 1984) (ICC retained consultant to evaluate various methodological criticisms of rulemaking record). As explained in *A Guide to Federal Agency Rulemaking* published by the ABA:

> Agencies sometimes use the services of outside consultants in developing rules or supporting analyses, particularly in rulemakings involving questions of science or technology as to which the agency needs added expertise. The tasks consultants are asked to perform vary, but they include testifying as witnesses, conducting research, summarizing and evaluating data in the record, and helping draft portions of the final rule and its rationale. Lubbers, *A Guide to Federal Agency Rulemaking* 243 (ABA 1998).

Clearly, therefore, those commenters who claimed that it was improper, per se, for OSHA to contract with expert witnesses to participate in the rulemaking process were wrong. *See e.g.*, Exs. 500–43, pp. 1–2; 500–201, p. 2. OSHA has also considered the more specific objections that: (1) OSHA did not disclose to the public that it had contracted with the expert witnesses to participate in the rulemaking proceedings; (2) the expert witnesses had a financial interest in the rulemaking and therefore their testimony was tainted; (3) OSHA coached the witnesses; (4) the expert witnesses provided additional detailed critiques of other public commenters that were not placed in the rulemaking record; and (5) OSHA improperly used the expert witnesses to review and analyze the public comments and hearing testimony. *See* Exs. 500–188, pp. 7–10; 500–197, pp. IV–1925.

First, the rulemaking record is replete with evidence that OSHA's use of expert witnesses and consultants was disclosed to the public and was clearly known to the parties who cross-examined OSHA's experts at the public hearings. OSHA notified interested members of the public of its expert witnesses in several ways: (1) OSHA clearly listed its expert witnesses as ''OSHA Witnesses'' on the hearing schedule that was sent to hearing participants and placed on the OSHA webpage, *see* Ex. 502–476; (2) OSHA placed the witnesses' testimony under a separate Exhibit number in the Docket Office labeled ''OSHA Expert Witnesses'', *see* Ex. 37; and (3) OSHA referred to its expert witnesses when responding to questions from members of the public during the first two days of the hearing. *See* Tr. pp. 1–142; 1–189; 1–205; 1–206; 1–229; 1–230; 719. Indeed, it was clear to the parties who cross-examined OSHA's experts that OSHA's experts were paid witnesses. For example, when an attorney representing UPS questioned OSHA witness Maurice Oxenburgh, he referenced the ''Expert Witness Cont[r]act for Dr. Maurice Oxenburgh.'' Tr. pp. 2637; *see* also Tr. p. 1440.

Second, OSHA's expert witnesses had no financial interest, and therefore no conflict of interest, in the outcome of the ergonomics rulemaking. The basis for this objection, raised by NCE *et al.,* appears to be that, because many of the expert witnesses were well-known ergonomics experts, they would benefit financially from an ergonomics standard, presumably because they would be hired more often to address ergonomic issues. According to this theory, the witnesses testified that there was a need for a standard on ergonomics in order to receive this future, speculative economic benefit. *See e.g.,* Ex. 500–197, p. IV–19.

In fact, however, OSHA hired these witnesses precisely because their experience with ergonomics provided them with relevant expertise. And their testimony shows clearly why most of them supported promulgation of this standard: they have participated in the implementation of ergonomics programs similar to those required by this standard, and have observed the success of those programs in reducing MSD rates, increasing productivity and efficiency, and decreasing workers' compensation costs. In other words, they believe that a program standard is necessary because they have seen programs work to reduce injuries among workers and save money for their employers. *See e.g.*, Exs. 37–7; 37–25; 37–20.

Third, there is no basis for the claim that OSHA improperly ''coached'' the expert witnesses. One of the witnesses'' functions was to help the public understand the scientific and technical research on which OSHA based its proposal. OSHA worked with its experts to be sure that they were prepared to explain clearly and succinctly, the reasoning and assumptions on which OSHA relied in developing the proposed standard. Indeed, OSHA believes that it had a responsibility to prepare its expert witnesses to present the scientific and technical assumptions that underlay the proposal. This preparation, however, does not represent improper ''coaching'' the witnesses. *See Lead*, 647 F.2d at 1211–16. None of the expert witnesses testified to anything they did not believe; in fact, some criticized aspects of the proposed rule with which they disagreed. *See e.g.*, Testimony of Les Boden, Tr. pp. 1683–34 (''Even though I happen to be here at the request of OSHA, I think it's clear that OSHA should reword the language that describes WRP so that people like myself, when they first read it, won't think that it means that the worker is supposed to be paid 90 percent of their after tax earnings * * * .''); Testimony of Laura Punnett, Tr. p. 1011 (''I would prefer to see a standard which is based on exposure levels * * * and which does not require the occurrence of disorders before a program goes into place.'').

Fourth, OSHA's expert witnesses did not prepare any detailed written critiques of public witnesses during the rulemaking process that OSHA could have, but did not place in the rulemaking record. The commenter who made this allegation, the Chamber, gave no support for it, but rather summarily stated: ''the Chamber *understands* that many of these supposed experts have *apparently* prepared detailed critiques of the public comments the Agency received, which have never been released to the public, much less subjected to rebuttal or cross-examination.'' Ex. 500–188, p. 8 (emphasis added). This allegation is not true. As detailed above, OSHA placed in the docket all of the information it relied upon in promulgating the standard.

Fifth and finally, OSHA did not improperly involve expert witnesses in the preparation of the proposed and final rule, and in the review and analysis of the public comments and hearing transcripts. It is true that OSHA hired some experts to help in preparing the proposed and final rule and in evaluating the rulemaking record; however, such use of experts is not improper. As described above, it is expressly authorized by the OSH Act and has been upheld by the D.C. Circuit Court of Appeals. *Lead*, 647 F.2d at 1216 (OSHA properly hired experts ''to summarize and evaluate data in the record, prepare record data for computer processing, and help draft portions of the Preamble and the final standard.''). In the end, OSHA must weigh the evidence and determine whether a standard is appropriate and how that standard should be designed to substantially reduce a significant risk of material harm. After examining all of the evidence in the rulemaking record—evidence that was subject to notice and comment—OSHA has made the determination that this standard is reasonably necessary and appropriate to reduce the significant risk of MSDs. OSHA's use of experts in helping to make that determination was not improper or inappropriate.

E. Supplemental Hearing on the Economic Impact of the Proposed Standard on the United States Postal Service, State and Local Governments, and Railroads

After OSHA published the proposed standard on November 23, 1999, it realized that it had failed to include in its Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis an assessment of the economic impact of the proposed standard on the United States Postal Service, State and local governments, and railroads. Once OSHA recognized the omission, it conducted a supplemental analysis of the economic impact of the proposed standard on these groups (supplemental analysis) and published the analysis in the **Federal Register**. See 65 FR 33263 (May 23, 2000).

In order to allow interested parties an opportunity to comment on the supplemental analysis, which consisted only of 2 **Federal Register** pages (with a 10 page Technical Appendix), OSHA established a 30 day pre-hearing comment period, scheduled an informal public hearing on the supplemental analysis, and established a 34 day post-hearing comment period. 65 FR 33263 (May 23, 2000). The post-hearing comment period for the supplemental analysis closed the same day as the post-hearing comment period for the rest of the proposed standard. Id.

The hearing took place on July 7, 2000 in Atlanta, GA, and 8 parties filed Notices of Intent to Appear. See Exs. 701; 702. The hearing was scheduled to begin at 9:00 a.m. and conclude by the end of the day. 65 FR 37322, 37323 (June 14, 2000). An OSHA panel was available for questioning on the supplemental analysis from 9:15 a.m. until 12:00 p.m. A representative of UPS questioned the panel for more than two hours, and the presiding Administrative Law Judge permitted one person who had not filed a Notice of Intent to Appear to question OSHA for about 10 minutes. *See* Tr. pp. 18153–55; 18218. A representative of the railroad industry was the only party to present testimony at the afternoon session—the others having canceled their appearances—and the hearing concluded early. See Tr. pp. 18217–81.

OSHA's issuance of the supplemental analysis and procedures for comment on the analysis were consistent with applicable law. As described in detail above, the OSH Act and OSHA's procedural regulations require that OSHA provide at least 30 days for interested parties to comment on a proposed rule. 29 U.S.C. 655(2); 29 CFR 1911.11(b)(3). OSHA gave interested parties such an amount of time to submit pre-hearing comments on the supplemental analysis.

OSHA's procedures for seeking comment were also adequate to allow interested parties an opportunity to meaningfully comment on the supplemental analysis. The supplemental analysis was based in large measure on the original Preliminary Economic Analysis published on November 23, 1999. Id. at 33264. Interested parties, therefore, were familiar with the methodology employed by OSHA in the supplemental analysis before it was published on May 23, 2000. Indeed, virtually all of the parties who filed a Notice of Intent to Appear at the informal public hearing on the supplemental analysis (or who submitted written comments on the supplemental analysis) also filed written comments on the November 23, 1999 proposal. *See e.g.,* Comments of the United States Postal Service, Ex. 35–106; Comments of the Association of American Railroads, Ex. 30–3750; Comments of UPS, Ex. 32–241–4.

Because it was based on the earlier Preliminary Economic Analysis, the supplemental analysis was not a large, complicated document. *See e.g.,* Ex. 28–15 (Technical Appendix). Interested parties did not need to review numerous additional documents to prepare written comments. In addition, the industries analyzed in the supplemental analysis represented only a small fraction of the total industries affected by the proposed rule.

OSHA therefore disagrees with those commenters who contended that, by setting a 30 day pre-hearing comment period and by failing to provide a bifurcated post-hearing comment period (*i.e.,* the first part of the period for submission of additional data and evidence and the second part for post-hearing briefs and argument), OSHA did not provide for adequate comment on the supplemental analysis. OSHA gave interested parties more than 60 days to comment on the supplemental analysis (including the pre-hearing and post-hearing comment period); OSHA believes this period of time was more than adequate to allow interested parties to review the relevant record material, submit written comments and data, and prepare for the informal public hearing. In fact, the information supplied by the railroad industry was largely responsible for OSHA's decision to reserve for possible future rulemaking the issue of the applicability of the final rule to the railroad industry. See Discussion in Part IV, Paragraph (b) above.

F. The Post-Hearing Comment Period

As stated above, the Hearing Procedures established a 90 day post-hearing comment period for the rulemaking. 65 FR 11948, 11949 (Mar. 7, 2000). During the first 45 days of the period (until June 26, 2000), hearing participants could submit additional data and evidence to the rulemaking record. *Id.* Hearing participants had until August 10, 2000 to submit post-hearing briefs and arguments. Furthermore, trade associations or other groups who filed Notices of Intent to Appear were permitted to attach to their post-hearing submissions comments from their members who had not participated in the informal public hearing. *See e.g.,* Ex. 500–1. Numerous hearing participants availed themselves of the post-hearing comment period. For example:

- NCE *et al.* submitted 906 pages of new information and data and submitted a 565 page brief. See Exs. 500–118; 500–197.
- The Chamber submitted 22 pages of new information and data and submitted a 107 page brief. See Exs. 500–109; 500–188.
- The AFL–CIO submitted 2072 pages of new information and data and submitted a 178 page brief. See Exs. 500–71; 500–97; 500–218.
- The American Iron and Steel Institute submitted 186 pages of new information and data and submitted a 129 page brief. See Exs. 500–168; 500–223.

OSHA and its expert witnesses also participated in the post-hearing comment period. OSHA submitted new evidence and data it had obtained since publication of the proposal to the docket by June 26, 2000. See Ex. 502. Some of OSHA's expert witnesses also submitted new data, information, and argument at this time. *See e.g.,* 500–38; 500–134; 500–84. A few expert witnesses also submitted argument after June 26, 2000. *See e.g.,* 500–167. These arguments were postmarked on or before August 10, 2000, in accordance with the Hearing Procedures. 65 FR 11948, 11949 (Mar. 7, 2000).

The 90 day post-hearing comment period and OSHA's participation in it were consistent with Agency practice in past OSHA rulemakings, and did not deprive any member of the public the opportunity to comment on relevant evidence. Past OSHA rulemakings have included post-hearing comment periods of similar length. For example:

- Powered Industrial Trucks—90 day post-hearing comment period. 63 FR 66237 (Dec. 1, 1998).
- Cadmium—90 day post-hearing comment period. 57 FR 42101 (Sept. 14, 1992).
- Process Safety Management—90 day post-hearing comment period. 57 FR 6356 (Feb. 24, 1992).
- Hazard Communication—93 day post-hearing comment period. 48 FR 53280 (Nov. 25, 1983).

Indeed, in the Air Contaminants rulemaking the Secretary of Labor established a 77 day post-hearing comment period, a shorter period than that provided here. 53 FR 34708 (Sept. 7, 1988). As described in more detail above, the time allotted for comment in that rulemaking was challenged in the 11th Circuit Court of Appeals, which held that those comment periods did not deprive individuals of the opportunity to comment meaningfully. Air Contaminants, 965 F.2d at 969 n.8.

Here, too, OSHA believes that the 90 day post-hearing comment period was more than adequate to allow interested parties an opportunity to submit additional data and argument on the proposed rule. As stated above, parties who participated in the informal public hearing had 216 days, including the 90 day post-hearing comment period, from the date OSHA published the proposed rule to submit data and evidence to the rulemaking record for OSHA's consideration. They had 261 days from the date OSHA published the proposed rule to submit briefs and arguments to the rulemaking record. OSHA believes that this gave interested parties more than enough time to review the record, comment on the evidence submitted, and comment on the proposed rule.

In addition, the participation of OSHA and its expert witnesses in the post-hearing comment period was not improper. *See* Ex. 803–2. First, the Hearing Procedures did not preclude OSHA and its expert witnesses from participating in the post-hearing comment period. See 803–2. In past rulemakings, OSHA and its expert witnesses have participated fully in post-hearing comment periods by submitting data, evidence, and argument. *See e.g.,* Docket S775 (Steel Erection); Docket H225 (Formaldehyde); Docket S048 (Logging); Docket H049 (Respiratory Protection). For OSHA and its expert witnesses not to submit additional data and information it becomes aware of in the post-hearing comment period would be negligent, given OSHA's mandate to consider the ''best available evidence'' in promulgating a standard. It would also give rise to the charge that OSHA was relying in the final standard on non-record evidence.

Second, in accordance with the Hearing Procedures, OSHA and its expert witnesses submitted all new data and evidence by June 26, 2000. Although some of the material was not scanned into the computer database until later, all of the information was available after June 26, 2000, in hard copy form in the Docket Office. OSHA even prepared a finding aid to help interested members of the public locate and review the information submitted. Thus, interested members of the public had an opportunity to review and comment on all new data and evidence submitted by OSHA and its expert witnesses. OSHA admits that a handful of its expert witnesses, like many other Hearing Participants, submitted post-hearing argument on August 10, 2000. *See e.g.*, Exs. 500–167; 500–187; 500–173. As explained above, this was permitted under the Hearing Procedures. 65 FR 11948, 11949 (Mar. 7, 2000). OSHA does not believe that these submissions constituted new information or data, as some commenters suggested. See 803–2. Rather, these submissions interpreted and analyzed evidence and data that were already a part of the rulemaking record. In any events, OSHA has not relied in the final standard on comments from its expert witnesses submitted after June 26, 2000.

OSHA acknowledges that NIOSH submitted a handful of new studies to the rulemaking record after the June 26, 2000 deadline. Because of this, OSHA has not relied upon these studies in promulgating this final rule; OSHA has also not relied upon the conclusions NIOSH reached in its post-hearing brief as evidence in the final standard, even though OSHA believes that NIOSH's post-hearing brief represents argument, not new data and evidence. OSHA has considered, however, the numerous studies NIOSH submitted in accordance with the Hearing Procedures on June 26, 2000. *See* Ex. 500–121. In short, OSHA is not relying in this standard on any information that interested parties did not have an opportunity to comment upon.

Finally, OSHA notes that some Hearing Participants submitted new evidence and data to the rulemaking record on August 10, 2000. *See e.g.,* Ex. 500–219. This new data and evidence was not submitted in accordance with the Hearing Procedures and other hearing participants did not have an opportunity to comment upon it during the post-hearing comment period. *See* 65 FR 11948, 11949 (Mar. 7, 2000). OSHA is thus under no obligation to consider it in promulgating the final rule. Even so, OSHA has examined the information and data carefully and given it appropriate consideration (consistent with the fact that it has not been subject to rebuttal by other hearing participants).

For these reasons, OSHA does not agree with those commenters who have implied that the post-hearing comment period was too brief or that OSHA and its expert witnesses improperly participated in the post-hearing comment period. *See e.g.,* Exs. 803–2; 500–197, p. IV–9.

XIII. Federalism

OSHA has reviewed the final ergonomics program rule in accordance with the Executive Order on Federalism (Executive Order 13132, 64 FR 43255, August 10, 1999). This Order requires that agencies, to the extent possible, refrain from limiting state policy options, consult with States prior to taking any actions that would restrict state policy options, and take such actions only when there is clear constitutional authority and the presence of a problem of national scope. The Order provides for preemption of State law only if there is a clear Congressional intent for the agency to do so. Any such preemption is to be limited to the extent possible.

Section 18 of the Occupational Safety and Health Act (OSH Act) expresses Congress' clear intent to preempt State laws with respect to which Federal OSHA has promulgated occupational safety or health standards. Under the OSH Act a State can avoid preemption only if it submits, and obtains Federal approval of, a plan for the development of such standards and their enforcement. Occupational safety and health standards developed by such State Plan States must, among other things, be at least as effective as the Federal standards in providing safe and healthful employment and places of employment.

Since many work-related MSDs are reported every year in every State and since MSD hazards are present in workplaces in every state of the Union, the risk of work-related MSD disorders is clearly a national problem. The Federal final ergonomics program standard is written so that employees in every State would be protected by the standard. To the extent that there are any State or regional peculiarities, States with occupational safety and health plans approved under Section 18 of the OSH Act would be able to develop their own comparable State standards to deal with any special problems.

In short, there is a clear national problem related to occupational safety and health for employees exposed to MSD hazards in the workplace. Any rule pertaining to ergonomics developed by States that have elected to participate under Section 18 of the OSH Act would not be preempted by this final rule if the State rule is determined by Federal OSHA to be ''at least as effective'' as the Federal rule. California has already promulgated a final ergonomics standard, and so has Washington. The State of North Carolina has proposed one. Because the ergonomics program standard may preempt State rules that are not ''at least as effective'' as the Federal rule, OSHA has determined that it has ''federalism implications'' as defined in Executive Order 13132. The order requires consultation with State and local governments for regulations that have federalism implications.

In the course of OSHA's development of this final standard for ergonomics, OSHA solicited and received a great deal of participation from representatives of state, county and municipal governments. Some representatives participated by attending one or more stakeholder meetings held by OSHA in the early stages of the rulemaking effort. Others participated by submitting written comment or testifying at the public hearing. Below is a listing of those who participated in the rulemaking process.

Representatives of the following state, county, and municipal entities attended one or more of the OSHA-sponsored stakeholder meetings addressing the Ergonomic Program Standard:

The City of Greensboro, N.C.; the Virginia State Department of Labor and Industry; the State of Hawaii Department of Labor; the Washington State Department of Labor and Industries; Iowa OSHA; the Maryland Occupational Safety and Health Administration; the New York State Department of Labor; the North Carolina Safety and Health Program, and Utah OSHA.

Representatives of the following state, county, and municipal entities were invited to attend one or more of the OSHA-sponsored stakeholder meetings addressing the Ergonomic Program Standard, but elected not to send a representative:

Cal/OSHA Consultation Services; California OSHA; the City of Casper, Wyoming; The City of Mt. Airy, North Carolina; the City of Portland, Oregon, Bureau of Risk Management; the North Carolina Department of Labor; the North

Carolina League of Municipalities; the Ohio Bureau of Workers' Compensation; Oregon OSHA; the State of Kansas Consultation Program, and the Texas Workers Compensation Insurance Fund.

Representatives of the following state, county, and municipal entities provided comments to the public rulemaking docket for the proposed Ergonomic Program Standard (Docket S–777):

Butler Rural Elec Cooperative Inc. (Exs. 30–182 and 30–239); North Park Public Water District (Ex. 30–212); City of Garner (Ex. 30–219); Colchester Public Works (Ex. 30–247); Appomattox River Water Authority (Ex. 30–248); South Island Public Services District (Exs. 30–252; 30–281; and 30–354); Des Moines Water Works (Exs. 30–254 and 30–279); Mishawaka Utilities (Exs. 30–255 and 30–278); Public Works Department (Ex. 30–257); Saginaw Midland Municipal Water Supply Corp (Ex. 30–258); Board of Public Utilities (Ex. 30–261); City of Nashville (Ex. 30–270); Stroudsburg Municipal Authority (Ex. 30–271); City of Laurel (Ex. 30–272); City of Drain (Ex. 30–273); McCormick Comm of Public Works (Ex. 30–274); Ilion Water Comm Municipal Building (Ex. 30–275); Rural Lorain County Water Authority (Ex. 30–285); Winchester Municipal Utilities (Ex. 30–286); Ohio Rural Elec Cooperatives Inc. (Ex. 30–297); St. Louis County Water Co (Ex. 30–302); City of East Jordan (Ex. 30–304); Clarksdale Public Utilities (Ex. 30–305); Westmont Water Department (Ex. 30–342); Bucks County Water and Sewer Authority (Ex. 30–343); Town of Hillsborough (Ex. 30–347); Department of Water Supply (Ex. 30–356); the City of Portsmouth (Ex. 30–357); Cedar Rapids Water Department (Ex. 30–366); State of Maine Comm on Labor (Ex. 30–376); City of Elko (Ex. 30–377); Arizona School Alliance (Ex. 30–382); New Jersey AM Water Co (Ex. 30–402); Fayette County Hospital (Ex. 30–420); Mohave Union High School District Number 30 (Ex. 30–433); Cartwright School District Number 83 (Ex. 30–439); City of Murfreesboro (Ex. 30–440); Gurnee Public Works (Ex. 30–450); City of David City (Ex. 30–482); Cartwright School District Number 83 (Ex. 30–492); Tualatin Valley Water District (Ex. 30–495); United Water Conservation District (Ex. 30–500); Shoshone Municipal Pipeline (Ex. 30–501); South Fulton (Ex. 30–504); City of Hood River (Ex. 30–505); Municipal Authority of the Township of Robinson (Ex. 30–507); City of Petersburg (Ex. 30–508); Town of Greensboro (Ex. 30–510); Thermalito Irrigation District (Ex. 30–512); McCloud Comm Services District (Ex. 30–513); State of Kansas Department of Human Resources (Ex. 30–522); Salt River Project (Ex. 30–526); HI Desert District Water (Ex. 30–549); Clear Creek Comm Services District (Ex. 30–553); Cucamonga County Water District (Ex. 30–558); Ramona Municipal Water District (Ex. 30–578); Clackamas River Water (Ex. 30–579); State University of New York (Ex. 30–584); Kyrene School District (Ex. 30–590); Arizona School Alliance (Ex. 30–591); Pennsylvania State Representative (Ex. 30–599); The Arlington Chamber (Ex. 30–600); Anchorage Water and Wastewater Utility (Ex. 30–622); Multnomah County Oregon (Exs. 30–637 and 500–18); Gilbert Public Schools (Ex. 30–691); Elsinore Valley Municipal Water District (Ex. 30–693); District of Columbia Water and Sewer Authority (Ex. 30–702); Bullhead City Schools (Ex. 30–704); Mukilteo Water District (Exs. 30–714 and 30–982); City of Tampa Water Department (Ex. 30–869); the Industrial Commission of Arizona (Ex. 30–877); Valley County Water District (Ex. 30–880); Plainview Water District (Ex. 30–900); Lake Hemet Municipal Water District (Ex. 30–902); Jordan Valley Water Conservancy District (Ex. 30–916); City of David City and David City Utilities (Ex. 30–1002); Bellevue Department of Public Works (Ex. 30–1003); City of Nooksack (Ex. 30–1009); Multnomah County Department of Support Services (Ex. 30–1018); Kentucky Labor Cabinet (Ex. 30–1024); Olivehain Municipal Water District (Ex. 30–1039); Oregon Department of Consumer and Business Services (Ex. 30–1110); North Park Public Water District (Ex. 30–1114); Board of Public Utilities (Ex. 30–1116); Village of Morrisville Water and Light Department (Ex. 30–1118); Pennsylvania Farm Bur (Exs. 30–1121; 30–1202; and 30–1204); Owatonna Public Utilities (Ex. 30–1124); City of Monona (Ex. 30–1125); Consumers Pennsylvania Water Co (Ex. 30–1127); Rock Rapids Utilities (Ex. 30–1128); Warminster Municipal Authority (Ex. 30–1130); June Lake Public Utility District (Ex. 30–1140); City Hall, City of Canyonville (Ex. 30–1206); Central New York Water Authority (Ex. 30–1212); Sanitary District No. 4 Town of Brookfield (Ex. 30–1247); Nevada Irrigation District (Ex. 30–1262); City of Boerne (Ex. 30–1265); Blacksburg Christainsburg VPI Water Authority (Ex. 30–1272); Casitas Municipal Water District (Ex. 30–1275); Jennings North West Regional Utilities (Ex. 30–1310); Ypsilanti Comm Utilities Authority (Ex. 30–1329); Mammoth Comm Water District (Ex. 30–1376); City of Elko City Hall (Ex. 30–1413); Charter Township of Independence (Ex. 30–1415); Town of Oyster Bay, N.Y. (Ex. 30–1447); Clear Creek Community Services District (Ex. 30–1471); Washington Suburban Sanitary Commission (Ex. 30–1508); Contra Costa Water District (Ex. 30–1526); Bona Vista Water Improvement District (Ex. 30–1527); Stanislaus County (Ex. 30–1531); Alaska Municipal League (Ex. 30–1536); Long Beach Public Transportation Co. (Ex. 30–1539); Municipal Association of South Carolina (Ex. 30–1583); Salem County Utilities Authority (Ex. 30–1714); Texas Department of Criminal Justice (Ex. 30–1847); Western Governors Association (Ex. 30–2036); State of Kansas Department of Human Resources (Ex. 30–2041); Public Hospital District No. 1 of Pend Oreille County (Exs. 30–2731 and 30–4103); Oregon Department of Consumer and Business Services (Ex. 30–3022); Point Lookout Village (Ex. 30–3073); Oswego County Ambulance (Ex. 30–3186); Louisville Water Company (Ex. 30–3187); Richmond Ambulance Authority (Ex. 30–3311); New York Department of Labor (Ex. 30–3731); Elizabethtown Water Company (Ex. 30–3739); PIMA County Risk Management Department (Ex. 30–3968); New York State Thruway Authority (Ex. 30–4057); Montana State Fund (Ex. 30–4847); Commonwealth of Pennsylvania Department of Labor and Industry (Ex. L–30–4932); Attorney General of Missouri (Ex. L–30–5216); Nevada City School District (Ex. 31–23); City of Ridgecrest (Ex. 31–135); City of De Pere (Ex. 31–137); Sonoma County Water Agency (Ex. 31–146); Denver Public Schools (Ex. 31–180); Porter Hills Presbyterian Village (Exs. 31–209 and 30–220); Stark County Department of Human Services (Ex. 31–213); San Diego City Schools (Ex. 31–234); Fairfax County Government Risk Management Division (Ex. 31–306); Lewis County Public Health (Ex. 31–308); Washington State Farm Bureau (Ex. 31–312); Indiana Association of Cities and Towns, for Richmond Indiana (Ex. 31–328); State of New Mexico Workers Compensation Admin (Exs. 500–13–1 thru 500–13–5); Washington Department of Labor and Industry (Exs. 500–20–1 thru 500–20–8); Oregon Department of Consumer and Business Services (Ex. 500–28–1); Washington State Department of Labor and Industry (Exs. 500–41–1 thru 500–41–120); State of Oregon Department of Consumer and Business Services (Ex. 500–71–22); Washington State Department of Labor and Industry (Ex. 500–86); Oregon Department of Insurance and Finance (Ex. 500–141–1); Oregon Workers Compensation Department (Ex. 500–141–2); Oregon Department of Insurance and Finance (Ex. 500–141–3); New Mexico Workers Compensation Administration (Ex. 500–184–1); City of Portland Environmental Services (Ex. 501–4); Washington State (Ex. 502–67); Alaska Department of Labor (Ex. 502–98); California Department of Labor (Ex. 502–104); California Office of Occupational Safety and Health (Ex. 502–106); California Department of Industrial Relations (Ex. 502–220); Pittsburgh County Memorial Hospital (Ex. 502–285); Allouez Water Department (Ex. 600–X–15); Goshen Water and Sewer Plant (Ex. 600–X–16); Stevens Point Water and Sewage Treatment Department (Ex. 600–X–18); City of George West (Ex. 600–X–19); Pennsylvania AM Water Company (Ex. 600–X–20); City of Cuyahoga Falls (Ex. 600–X–21); Water and Light Department (Ex. 600–X–22); Mars Hill Utility District (Ex. 600–X–23); Marshall County Board of Public Utilities (Ex. 600–X–24); The City of North Myrtle Beach (Ex. 600–X–25); Niagara County Water District (Ex. 600–X–26); Old Hickory Utility District of Davidson County (Ex. 600–X–27); Bella Vista Water District (Ex. 600–X–28); Columbus Water Works (Ex. 600–X–29); Dept of Engineering and Public Works (Exs. 600–X–31 and 600–X–67); North Carolina General Assembly (Ex. 601–X–391); New Jersey State League of Municipalities (Ex. 601–X–444); the Commonwealth of Massachusetts (Ex. 601–X–630); Florida House of Representatives (Exs. 601–X–712 and 601–X–838); Texas House of Representatives (Ex. 601–X–946); State of Tennessee (Ex. 601–X–980); Utah State Senate (Ex. 601–X–1013); West Virginia Municipal League (Ex. 601–X–1125); Rhode Island League of Cities and Towns (Ex. 601–X–1133); New Jersey State League of Municipalities (Ex. 601–X–1134); and the City of Portland Oregon (Ex. 601–X–1494).

In addition, representatives of the following state, county, and municipal entities gave oral testimony at the informal public hearings on the proposed Ergonomic Program Standard:

The New York State Attorney General; the National League of Cities; the Montgomery County (Ohio) Administration; the State of New Mexico Worker's Compensation Administration; the State of California Department of Health and Human Services; the City of Portland, Oregon; the Multnomah County, Oregon Government; the Oregon Workers' Compensation Division and the State of Washington Department of Labor and Industries.

Representatives of the following state, county, and municipal entities provided written comments at the informal public hearing on the proposed Ergonomic Program Standard:

The Wisconsin Department of Industry and Labor (Ex. DC–78); the New Jersey Department of Health and Senior Services (Ex. DC–109A); Montgomery County, Ohio (Ex. Il–169); the New Mexico Workers' Compensation Administration (Ex. Il–222); the City of Portland, Oregon (Ex. Or–324); the Oregon Department of Consumer and Business Services (Ex. Or–350–1); the State of Oregon Board of Dentistry (Ex OR–351–9); the National League of Cities (Ex. DC–371) and the Washington State Department of Labor and Industry (Exs. DC 417, 417–1 and 417–2).

OSHA's ergonomics rulemaking process has thus involved hundreds of representatives from every level of government. Many State governments (*e.g.*, Maine, Washington, Oregon, Kansas, Arizona. Kentucky, Pennsylvania, New York, Nevada, Texas, Montana, Missouri, New Mexico, Alaska, California, Indiana, North Caroline, Massachusetts, Florida, Tennessee, Utah and local and municipal governments (*e.g.*, Nashville, TN; Portsmouth, VA; Petersburg, AK; Greensboro, NC; Multnomah County, OR; District of Columbia, Blackburn-Christainsburg, VA; Ypsilanti, MI; Long Beach, CA; Denver, CO; Richmond, IN; Montgomery County, OH) participated either by appearing in person at the hearings or submitting written comments. Municipal and State entities represented included, water districts, school districts, electrical utilities, public works departments, municipal authorities, hospitals and long-term care facilities, labor commissions, human resource departments, universities, legislative bodies, industrial commissions, workers' compensation administrations, public transportation systems, emergency medical services, public highway authorities, emergency medical services, public highway authorities, state insurance funds, public health departments, and environmental services.

Representation by governmental entities has been greater for this rule than for any other OSHA rule. OSHA has benefitted from the information and data provided by these representatives at stakeholder meetings held during the years the standard was under development, and the Agency has carefully reviewed and considered the oral testimony and written submissions of the participants. Many of their comments are addressed throughout the preamble to the final rule, others are discussed below.

An examination of the comments revealed that many commenters shared similar concerns and views on how to remedy those concerns. OSHA received hundreds of comments, for example, expressing concern that the proposed standard lacked clarity. Over 80 of these comments were identical, raising concerns about coverage, costs and how to comply. For example, many commenters said:

* * * The lack of specificity throws OSHA's estimates of range of impact and cost to employers into serious question. It also leaves employers attempting to comply in good faith at risk of non-compliance. Based on these concerns, I therefore, request that OSHA review its proposed ergonomics standard and provide clarification about both what kind of work and what types of workers are covered by it.

Commenters asked that OSHA clarify its exemption of construction work. OSHA has responded in depth to these concerns in the summary and explanation of the rule (see the discussion for paragraph (b), Does this standard apply to me?) Other commenters asked for clarification as to the application of the rule to the agricultural industry, inmates in penal institutions, the manufacturing industry, the ambulance industry, and the solid waste management industry. These issues are also addressed in the summary and explanation for paragraph (b). Some of the specific comments are discussed in greater detail below.

Some commenters complained the proposal was too long; the comment period too short and then questioned the science used by OSHA, suggesting that OSHA table its work until the National Academy of Sciences completes its second literature review. (Exs.30–1018; 30–1536; and 30–1847). Comments addressing procedural issues are discussed in the Procedural Issues section of the preamble; those on the science supporting this rule are reviewed in the Health Effects section (Section V).

The Des Moines Water Works, the Oregon Department of Consumer and Business Services, the Alaska Municipal League, and the Long Beach Public Transportation Company (*See, e.g.,* Exs. 30–254; 30–1110; 30–1536; 30–1539;), among many others, expressed concerns regarding the effect of the rule on Workers' Compensation Systems and suggested that workers' comp is an area best left to the states to address. Some commenters questioned whether OSHA had the authority to address issues related to workers' compensation systems and questioned whether OSHA's cost estimates included the cost to be expended by ''every company in the nation in renegotiate their workers compensation premium costs with insurance companies for these WRP payments?'' (Ex. 30–254). Issues raised by commenters about workers' compensation and its relation, or lack of it, to OSHA's work restriction protections, are responded to in the summary and explanation for paragraph (r).

The Pennsylvania Farm Bureau (Ex. 30–1121) said the proposal raised concerns for farm employers even though OSHA did not propose to apply the rule to agriculture. One concern cited by this commenter was that farmers would be affected by higher costs passed on to them by suppliers and others directly impacted by the rule. Another concern expressed by the Bureau was the extent to which agricultural operations were exempt from the rule. The Bureau cited various OSHA interpretations and language used to clarify when general industry and agricultural standards applied as the reason for their concern. The Pennsylvania Farm Bureau stated that OSHA should exclude agriculture from the coverage of the proposed standard. Similar concerns on this issue were raised by the Pennsylvania Farm Bureau, the New York Farm Bureau, the North Carolina Farm Bureau Federation, and others (*See e.g.,* Ex. 30–1201; 30–1418; 30–1421) as well as individual farmers (*See e.g.,* Ex. 30–1202 and 30–1204). OSHA notes that the final Ergonomic Program Standard does not apply to agricultural operations. A full and complete discussion of this issue can be found in the summary and explanation for paragraph (b), Does this standard apply to me?

Some commenters (Exs. 30–1536 and 30–1583) who are members of the National League of Cities (NLC) noted that the NLC does not support the application of the federal ergonomics standards to municipal governments. They cited their inability to obtain funding and their lack of technical resources to put an ergonomic program together as reasons for the objection. OSHA will provide considerable compliance assistance to the regulated community that may help NLC members reduce expenditures and develop solutions. These materials will be listed on OSHA's website at *www.osha.gov.*

The Salem County Utilities Authority (Ex. 30–1714) registered their support for the position of the National Solid Wastes Management Association's (NSWMA) request that the solid waste management industry be exempt from the ergonomic program standard. This commenter listed a number of reasons similar to those set out by OSHA in the proposed rule as the basis for the exemption of the construction, maritime and agricultural industries. OSHA's response to NSWMA's concerns are addressed in connection with paragraph (b) of the summary and explanation.

The Texas Department of Criminal Justice (TDCJ) (Ex. 30–1847) requested an exemption for correctional worker positions and asked for clarification of the applicability of the rule to prisoners assigned to manufacturing positions. Like other commenters, TDCJ expressed concern about the number of new staff that would be needed, in their view, to comply with the ergonomics program standard.

The Butler Rural Electric Cooperative, Inc. (Ex. 30–182) acknowledged the importance of an ergonomics program and provided details on the work already done by Butler; however, they believe that the OSHA ergonomics program standard is not necessary because OSHA could continue to rely on the General Duty Clause to do the job. In addition, Butler raised some concerns about the Work Restriction Protection provisions of the proposal, which they believe will encourage fraud. Again, these are areas of concern that have been raised by other commenters and are discussed at length in the summary and explanation section for paragraph (r).

The Stanislaus County (CA) Risk Management Division (Ex. 30–1531) suggested that more specific guidance was needed to help employers comply with the standard. They supported the grandfather clause, stating that ''Stanislaus County has saved millions of dollars over the last six years with the implementation of our injury and loss prevention program. One of these programs includes ergonomics.'' They support the grandfather clause because they believe ''There should be some incentive for those employers who are already making a good faith effort, with programs in place, to be rewarded, and we would encourage you to keep the grandfather clause.'' In response, OSHA notes that the final rule contains a grandfather clause (see paragraph (c)).

The Long Beach Public Transportation Company (Ex. 30–1539) stated their agreement with the fundamental concepts proposed by OSHA, but expressed some opposition regarding the classification of MSDs and the standard's potential impact on workers compensation laws. Long Beach Transportation encouraged OSHA ''to provide education to promote even more voluntary employer ergonomic programs to address the issues of MSDs.'' The concluding comment of this entity was that ''The Standard, as proposed, however would place an economic and regulatory burden on employers, would treat injured employees inequitably and would jeopardize voluntary systems already in place to address this issue.'' This view was also expressed by many commenters from state, county and municipal governments. In response, OSHA notes that employers and entities covered by the rule can anticipate to reap substantial benefits from their programs (see the discussion of the results achieved by others in the final economic analysis).

The Richmond Ambulance Authority (RAA) (Ex. 30–3311) stated that they ''applaud and support OSHA's effort to address ergonomic concerns in the workplace.'' This commenter then listed a few areas of concern and noted that the exemption criteria for industries with special compliance issues clearly apply to the ambulance industry. The RAA said that ''compliance efforts by members of the ambulance industry would be extremely costly'' and urged OSHA to exclude back pain from the kinds of MSDs covered.

OSHA is grateful to the many state, local, municipal, other government entities who have participated actively in this rulemaking. All the concerns raised by these commenters have been considered, and many changes to the rule have been made based on the comments and suggestions provided by these participants.

XIV. State Plans States

The 23 states and 2 territories which operate their own Federally-approved occupational safety and health plans must adopt a comparable standard within six months of the publication date of a final standard. These States include: Alaska, Arizona, California, Connecticut (for State and local government employees only), Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, New York (for State and local government employees only), North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Virgin Islands, Washington, Wyoming. Until such time as a state or territorial standard is promulgated, Federal OSHA will provide interim enforcement assistance, as appropriate.

XV. OMB Review Under the Paperwork Reduction Act of 1995

This final ergonomics program standard contains collections of information (paperwork) that are subject to review by the Office of Management and Budget (OMB) under the Paperwork Reduction Act of 1995 (PRA'95), 44 U.S.C. 3501 *et seq.* and its regulation at 5 CFR § 1320. PRA'95 defines collection of information to mean, ''the obtaining, causing to be obtained, soliciting, or requiring the disclosure to third parties or the public of facts or opinions by or for an agency regardless of form or format.'' [44 U.S.C. § 3502(3)(A)]. OSHA submitted an Information Collection Request (ICR) for OMB approval when the proposed rule for the ergonomic program standard was published on November 23, 1999. OMB did not approve the ergonomic program's information collection provisions at that time, but instructed the Agency that future ICR submissions should use the OMB control number 1218–0245. OSHA has submitted a final ICR estimating the paperwork burden hours and costs, to OMB as required by 5 CFR § 1320.11(h) for approval. Public comments regarding paperwork issues are addressed in the Summary and Explanation, and Cost and Benefit chapters of the final standard.

The following section provides information on the collections of information contained in the final ergonomics program standard, as required by 5 CFR § 1320.5(a)(1)(iv) and § 1320.8(d)(2) . It describes the collections of information, the need for and proposed use of the information, and the covered employers who will be required to collect and maintain information under the standard. The section also discusses the required time periods for collecting and maintaining this information, and provides an estimate of the annual cost and reporting burden. (Reporting burden includes the time for reviewing instructions, gathering and maintaining the data needed, and completing and reviewing the collection of information.)

Title: The ergonomics program standard, 29 CFR § 1910.900.

Description: The final ergonomics program standard addresses the significant risk of work-related MSDs confronting employees in various jobs in general industry workplaces. The standard's information collection requirements are essential components that will help employers and employees to recognize work-related MSDs and to determine what must be done to address these MSDs and MSD hazards in the workplace. OSHA compliance officers will use some of the information in their enforcement of the standard.

Summary of the Collections of Information: The final ergonomics standard requires employers to do the following: familiarize themselves with the final standard; provide basic ergonomic information to their employees; receive employees' reports of musculoskeletal disorders (MSDs) or MSD signs or symptoms; and determine if a reported MSD is work-related and if the employee's job meets the standard's Action Trigger. If an employee's job meets the standard's Action Trigger, the employer will incur additional paperwork requirements in complying with the ergonomics program requirement or the quick fix option.

MSD management is triggered when the employee experiences a work-related MSD that meets the Action Trigger and requires medical treatment beyond first aid, or involves MSD signs or MSD symptoms that last for 7 or more consecutive days after the employee first reports them to the employer. The employer must provide that employee with access to a health care professional (HCP). When the employee consults with an HCP, the employer must obtain a written opinion from the HCP and provide a copy of that opinion to the employee. The employer must provide the HCP with a description of the employee's job and information about the physical work activities, risk factors, and MSD hazards in the job; a copy of this standard; and a list of items that the HCP's written opinion must contain, including temporary work restrictions, if necessary.

Paperwork requirements for employers to develop and implement the ergonomic program include: management leadership, employee participation in the employer's ergonomic program, job hazard analysis, hazard control measures, and evaluation of the ergonomic program.

Employers with 10 or more employees, including part-time employees, must keep written or electronic records of the following: (i) Employee reports of MSDs, their signs and symptoms and MSD hazards, (ii) Employer's response to employee reports; (iii) Job Hazard Analysis; (iv) Hazard control measures, (v) Quick fix process, (vi) Ergonomics program evaluations, and (vii) Records of work restrictions and the HCP written opinions. Employers must keep all records, except the HCP written opinion, for 3 years or until replaced by updated records, whichever comes first. The HCP written opinion must be kept for the duration of the employee's employment plus 3 years.

Employers must provide employees, their representatives, OSHA, and NIOSH access to the above records, except the HCP opinions, for examination and copying in accordance with the procedures and time periods provided in 29 CFR 1910.1020(e)(1), (e)(2)(ii), (e)(3) and (f). Employers must provide the HCP opinion to employees, to anyone having the specific written consent of the employee, to OSHA, and to NIOSH upon request for examination and copying in accordance with the procedures and time periods provided in 29 CFR 1910.1020(e)(1), (e)(2)(ii), (e)(3) and (f).

Respondents: Employers in general industry. The standard does not apply to employment covered by the following OSHA standards, or to employment such as office management and support services directly related to that employment: (i) OSHA construction standards in Part 1926; (ii) OSHA's maritime standards in Part 1915, 1917, or 1918; or OSHA's agriculture standards in Part 1928. The standard also does not apply to railroad operations or to employment such as office management and support services directly related to the operation of a railroad.

Frequency of Response: All employers must provide basic ergonomic information to current and new employees. The frequency of other paperwork requirements is determined by whether the employer has an employee who has experienced an MSD incident, and whether the employee's job meets the standard's Action Trigger.

Average Time Per Response: Time per response varies, from minimal recordkeeping requirements for a quick fix situation, to establishing and implementing a complete ergonomics program.

Total Burden Hours: Approximately 36.5 million hours.

Estimated Costs (Operating and Maintenance): $61 million (purchasing services).

XVI. Authority and Signature

This document was prepared under the direction of Charles N. Jeffress, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor for Occupational Safety and Health, U.S. Department of Labor, 200 Constitution Avenue, NW, Washington, DC 20210.

This final standard is issued pursuant to sections 4, 6, and 8 Occupational Safety and Health Act, 29 U.S.C. 653, 655, 657, Secretary of Labor's Order No. 3–2000 (65 FR 50017) and 29 CFR Part 1911.

List of Subjects in 29 CFR Part 1910

Ergonomics program, Health, Musculoskeletal disorders, Occupational safety and health, reporting and recordkeeping requirements.

Signed at Washington, DC, this 6th day of November 2000.

Charles N. Jeffress,

Assistant Secretary of Labor for Occupational Safety and Health.

XVII. The Standard

The Occupational Safety and Health Administration is amending Part 1910 of title 29 of the Code of Federal Regulations as follows:

PART 1910—[AMENDED]

New Subpart W of 29 CFR Part 1910 is added to read as follows:

Subpart W—Program Standards

Sec.

1910.900 Ergonomics program standard.

Subpart W—Program Standards

Authority: Secs. 4, 6, and 8, Occupational Safety and Health Act, 29 U.S.C. 653, 655, 657, Secretary of Labor's Order No. 3–2000 (65 FR 50017); and 29 CFR Part 1911.

§ 1910.900 Ergonomics Program Standard.

(a) *What is the purpose of this standard?* The purpose of this standard is to reduce the number and severity of musculoskeletal disorders (MSDs) caused by exposure to risk factors in the workplace. This standard does not address injuries caused by slips, trips, falls, vehicle accidents, or similar accidents.

Note to paragraph (a): Definitions of terms used in this standard are in paragraph (z) of this section.

(b) *Does this standard apply to all employers?* This standard covers all employers covered by the Act with the following exceptions:

This standard does not apply to employment covered by the following OSHA standards, or to employment such as office management and support services directly related to that employment:

(i) OSHA's construction standards in Part 1926 of this chapter;

(ii) OSHA's maritime standards in Part 1915, 1917, or 1918 of this chapter; or

(iii) OSHA's agriculture standards in Part 1928 of this chapter.

(2) This standard does not apply to railroad operations or to employment such as office management and support services directly related to the operation of a railroad.

(c) *How does this standard apply if I already have an ergonomics program in place when the OSHA ergonomics program standard becomes effective?*

(1) You may continue to implement your program instead of complying with paragraphs (d) through (y) of this section, provided that your program is written, complies with the requirements of paragraph (c) of this section, has been implemented before November 14, 2000, and contains the following program elements:

(i) Management leadership, as demonstrated by an effective MSD reporting system and prompt responses to reports, clear program responsibilities, and regular communication with employees about the program;

(ii) Employee participation, as demonstrated by the early reporting of MSDs and active involvement by employees and their representatives in the implementation, evaluation, and future development of your program;

(iii) Job hazard analysis and control, as demonstrated by a process that identifies, analyzes, and uses feasible engineering, work practice, and administrative controls to control MSD hazards or to reduce MSD hazards to the levels below those in the hazard identification tools in Appendix D to this section or to the extent feasible, and evaluates controls to assure that they are effective;

Note to paragraph (c)(1)(iii): Personal protective equipment (PPE) may be used to supplement engineering, work practice, and administrative controls, but you may only use PPE alone where other controls are not feasible. Where PPE is used, you must provide it at no cost to employees.

(iv) Training of managers, supervisors, and employees (at no cost to these employees) in your ergonomics program and their role in it; the recognition of MSD signs and symptoms; the importance of early reporting; the identification of MSD hazards in jobs in your workplace; and the methods you are taking to control them; and

(v) Program evaluation, as demonstrated by regular reviews of the elements of the program and of the effectiveness of the program as a whole, using such measures as reductions in the number and severity of MSDs, increases in the number of jobs in which MSD hazards have been controlled, or reductions in the number of jobs posing MSD hazards to employees; and the correction of identified deficiencies in the program. At least one review of the elements and effectiveness of the program must have taken place prior to January 16, 2001.

(2) By January 16, 2002, you must have implemented a policy that provides MSD management as specified in paragraphs (p), (q), (r), and (s) of this section.

(3) An employer who has policies or procedures that discourage employees from participating in the program or reporting the signs or symptoms of MSDs or the presence of MSD hazards in the workplace does not qualify for grandfather status under paragraph (c) of this section.

(d) *If the standard applies to me, what initial action must I take?*

(1) You must provide each current and each new employee basic information about:

(i) Common musculoskeletal disorders (MSDs) and their signs and symptoms;

(ii) The importance of reporting MSDs and their signs and symptoms early and the consequences of failing to report them early;

(iii) How to report MSDs and their signs and symptoms in your workplace;

(iv) The kinds of risk factors, jobs and work activities associated with MSD hazards; and

(v) A short description of the requirements of OSHA's ergonomics program standard.

(2) You must make available to the employee a summary of the requirements of this standard.

(3) You must provide the information in written form or, if all employees have access, in electronic form. You must provide the information to new employees within 14 days of hiring. You must post the information in a conspicuous place in the workplace (*e.g.,* employee bulletin board or, if all employees have access, electronic posting).

Note to paragraph (d): You may use the information sheet in non-mandatory Appendix A to this section to comply with paragraphs (d)(1) of this section and the summary sheet in non-mandatory Appendix B to this section to comply with paragraph (d)(2) of this section.

(e) *What must I do when an employee reports an MSD or the signs or symptoms of an MSD?*

(1) You must promptly determine whether the reported MSD or MSD signs or symptoms qualify as an MSD incident. You may request the assistance of a Health Care Professional (HCP) in making this determination. A report is considered to be an MSD incident in the following two cases:

(i) The MSD is work-related and requires days away from work, restricted work, or medical treatment beyond first aid; or

(ii) The MSD signs or symptoms are work-related and last for 7 consecutive days after the employee reports them to you.

(2) If the employee has experienced an MSD incident, you must determine whether the job meets the standard's Action Trigger. See paragraph (f) of this section.

(3) If the employee has not experienced an MSD incident, you do not need to take further action.

(f) *How do I determine whether the employee's job meets the Action Trigger?*

(1) A job meets the Action Trigger if:

(i) An MSD incident has occurred in that job; and

(ii) The employee's job routinely involves, on one or more days a week, exposure to one or more relevant risk factors at the levels described in the Basic Screening Tool in Table W–1.

(2) If the employee's job does not meet the Action Trigger, you do not need to take further action.

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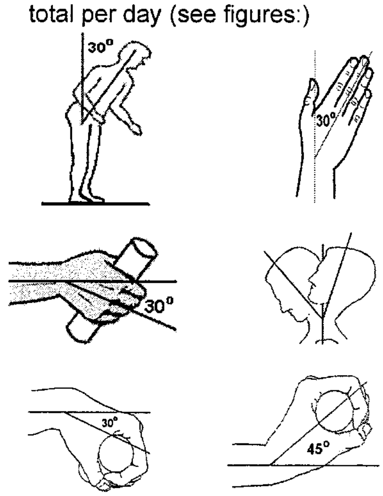
Table W-1 - Basic Screening Tool

You need only review risk factors for those areas of the body affected by the MSD incident.

		Body Part Associated With MSD Incident			
Risk Factors This Standard Covers	**Performing job or tasks that involve:**	Neck/ Shoulder	Hand/ Wrist/ Arm	Back/ Trunk/ Hip	Leg/ knee/ Ankle
Repetition	(1) Repeating the same motions every few seconds or repeating a cycle of motions involving the affected body part more than twice per minute for more than 2 consecutive hours in a workday.	√	√	√	√
	(2) Using an input device, such as a keyboard and/or mouse, in a steady manner for more than 4 hours total in a workday.	√	√		
Force	(3) Lifting more than 75 pounds at any one time; more than 55 pounds more than 10 times per day; or more than 25 pounds below the knees, above the shoulders, or at arms' length more than 25 times per day;	√	√	√	√
	(4) Pushing/pulling with more than 20 pounds of initial force (e.g., equivalent to pushing a 65 pound box across a tile floor or pushing a shopping cart with five 40 pound bags of dog food) for more than 2 hours total per day;	√	√	√	√
	(5) Pinching an unsupported object weighing 2 or more pounds per hand, or use of an equivalent pinching force (e.g., holding a small binder clip open) for more than 2 hours total per day;		√		
	(6) Gripping an unsupported object weighing 10 pounds or more per hand, or use of an equivalent gripping force (e.g., crushing the sides of an aluminum soda can with one hand), for more than 2 hours total per day.		√		

Table W-1 - Basic Screening Tool - continued

You need only review risk factors for those areas of the body affected by the MSD incident.

		Body Part Associated With MSD Incident			
Risk Factors This Standard Covers	**Performing job or tasks that involve:**	Neck/ Shoulder	Hand/ Wrist/ Arm	Back/ Trunk/ Hip	Leg/ knee/ Ankle
Awkward Postures	(7) Repeatedly raising or working with the hand(s) above the head or the elbow(s) above the shoulder(s) for more than 2 hours total per day;	√	√	√	
	(8) Kneeling or squatting for more than 2 hours total per day;			√	√
	(9) Working with the back, neck or wrists bent or twisted for more than 2 hours total per day (see figures:) 	√	√	√	
Contact Stress	(10) Using the hand or knee as a hammer more than 10 times per hour for more than 2 hours total per day;		√		√
Vibration	(11) Using vibrating tools or equipment that typically have high vibration levels (such as chainsaws, jack hammers, percussive tools, riveting or chipping hammers) for more than 30 minutes total per day;	√	√	√	
	(12) Using tools or equipment that typically have moderate vibration levels (such as jig saws, grinders, or sanders) for more than 2 hours total per day.	√	√		

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(g) *What actions must I take if the employee's job meets the Action Trigger?* For the employee's job and all jobs in the establishment that are the same as that job, you must either:

(1) Comply with the Quick Fix option in paragraph (o) of this section, or

(2) Develop and implement an ergonomics program that includes the following elements:

(i) Management leadership as specified in paragraph (h) of this section;

(ii) Employee participation as specified in paragraph (i) of this section;

(iii) MSD management as specified by paragraphs (p), (q), (r), and (s) of this section;

(iv) Job hazard analysis as specified by paragraph (j) of this section;

(v) Hazard reduction and control measures as specified in paragraphs (k), (l), and (m) of this section, and evaluations as specified in paragraph (u) of this section, if the job hazard analysis determines that the job presents an MSD hazard;

(vi) Training as specified in paragraph (t) of this section.

(h) *What must I do to demonstrate management leadership?* You must:

(1) Assign and communicate responsibilities for setting up and managing the ergonomics program;

(2) Provide designated persons with the authority, resources, and information necessary to meet their responsibilities;

(3) Ensure that your policies and practices encourage and do not discourage:

(i) The early reporting of MSDs, their signs and symptoms, and MSD hazards; and

(ii) Employee participation in the ergonomics program;

(4) Communicate periodically with employees about the ergonomics program and their concerns about MSDs.

(i) *What must I do to ensure employee participation in my program?* You must ensure that employees and their representatives:

(1) Have ways to promptly report MSDs, MSD signs and symptoms, and MSD hazards in your workplace;

(2) Receive prompt responses to their reports of MSDs, MSD signs and symptoms, and MSD hazards;

(3) Are provided with a summary of the requirements of this standard, as specified in paragraph (d)(2) of this section, and have ready access to a copy of this standard and to information about MSDs, MSD signs and symptoms, MSD hazards, and your ergonomics program; and

(4) Have ways to be involved in the development, implementation, and evaluation of your ergonomics program.

(j) *What must I do to determine whether a job that meets the Action Trigger poses an MSD hazard to employees in that job?*

(1) You must conduct a job hazard analysis for that job. You may rely on an analysis previously conducted in accordance with this section to the extent it is still relevant.

(2) Your job hazard analysis must include all employees who perform the same job, or a sample of employees in that job who have the greatest exposure to the relevant risk factors, and include the following steps:

(i) Talk with those employees and their representatives about the tasks the employees perform that may relate to MSDs; and

(ii) Observe the employees performing the job to identify the risk factors in the job and to evaluate the magnitude, frequency, and duration of exposure to those risk factors.

(3) You must use one or more of the following methods or tools to conduct this analysis:

(i) One or more of the hazard identification tools listed in Appendix D–1 to this section, if the tools are relevant to the risk factors being addressed;

(ii) The occupation-specific hazard identification tool in Appendix D–2 to this section;

(iii) A job hazard analysis conducted by a professional trained in ergonomics; or

(iv) Any other reasonable method that is appropriate to the job and relevant to the risk factors being addressed.

(4) If you determine that there is an MSD hazard in the job, the job will be termed a ''problem job.''

Note to paragraph (j): If you determine that the MSD hazards pose a risk only to the employee who reported the MSD, you may limit your job controls, training and evaluation to that individual employee's job.

(k) *What is my obligation to reduce MSD hazards in a problem job?*

(1) You must:

(i) Control MSD hazards; or

(ii) Reduce MSD hazards in accordance with or to levels below those in the hazard identification tools in Appendix D to this section; or

(iii) If you cannot reduce MSD hazards in accordance with paragraphs (k)(1)(i) or (k)(1)(ii) of this section, you must do the following:

(A) Reduce MSD hazards to the extent feasible;

(B) At least every 3 years, assess the job and determine whether there are additional feasible controls that would control or reduce MSD hazards; and

(C) If such controls exist, implement them until you have reduced the MSD hazards in accordance with paragraphs (k)(1)(i) or (k)(1)(ii) of this section.

(2) If a work-related MSD occurs in a job whose hazard(s) you have reduced to the levels specified in paragraph (k)(1) of this section, you must:

(i) Ensure that appropriate controls are still in place, are functioning, and are being used properly, and

(ii) Determine whether new MSD hazards exist and, if so, take steps to reduce the hazards as specified in paragraph (m) of this section.

Note to paragraph (k): The occurrence of an MSD in a problem job is not in itself a violation of this standard.

(l) *What kinds of controls must I use to reduce MSD hazards?*

(1) For each problem job, you must use feasible engineering, work practice or administrative controls, or any combination of them, to reduce MSD hazards in the job. Where feasible, engineering controls are the preferred method of control.

(2) You may use personal protective equipment (PPE) to supplement engineering, work practice or administrative controls, but you may use PPE alone only where other controls are not feasible. Where you use PPE, you must provide it at no cost to employees.

(m) *What steps must I take to reduce MSD hazards?* You must:

(1) Ask employees in the problem job and their representatives to recommend measures to reduce MSD hazards;

(2) Identify and implement initial controls within 90 days after you determine that the job meets the Action Trigger. Initial controls mean controls that substantially reduce the exposures even if they do not reach the levels specified in paragraph (k)(1) of this section.

(3) Identify and implement permanent controls that meet the levels specified in paragraph (k)(1) of this section within 2 years after you determine that a job meets the Action Trigger, except that initial compliance can take up to January 18, 2005 whichever is later.

(4) Track your progress and ensure that your controls are working as intended and have not created new MSD hazards. This includes consulting with employees in problem jobs and their representatives. If the controls are not effective or have created new MSD hazards, you must use the process in paragraphs (m)(1) and (m)(2) of this section to identify additional control measures that are appropriate and

implement any such measures identified.

(n) [Reserved].

(o) *May I use a Quick Fix instead of setting up a full ergonomics program?*

(1) You may use a Quick Fix for a job if your employees have experienced no more than one MSD incident in that job, and there have been no more than two MSD incidents in your establishment, in the preceding 18 months.

(2) To use a Quick Fix, you must:

(i) Provide the MSD management required by paragraphs (p), (q), (r), and (s) of this section, as appropriate, to the employee promptly after you determine that the employee's job meets the Action Trigger;

(ii) Talk with employees in the job and their representatives about the tasks the employees perform that may relate to the MSD incident; and

(iii) Observe employees performing the job to identify which risk factors are likely to have caused the MSD incident;

(iv) Ask the employee(s) performing the job and their representatives to recommend measures to reduce exposure to the MSD hazards identified;

(v) Within 90 days of your determination that the job meets the Action Trigger in paragraph (e) of this section, implement controls in the job in accordance with paragraph (l) of this section that control the MSD hazards or reduce MSD hazards in accordance with or to levels below those in the hazard identification tools in Appendix D to this section, and train the employee(s) in the use of these controls;

(vi) Within 30 days after you implement the controls, review the job to determine whether you have reduced the MSD hazards to the levels specified in paragraph (o)(2)(v) of this section; and

(vii) Keep a record of the Quick Fix process for each job to which it is applied. You must keep the record for 3 years.

(3) If you determine that you have reduced the MSD hazards to the levels specified in paragraph (o)(2)(v) of this section, you need take no further action except to maintain controls, the training related to those controls, and recordkeeping.

(4) If you have not reduced MSD hazards to the levels specified in paragraph (o)(2)(v) of this section, you must implement an ergonomics program, as specified in paragraph (g) of this section.

(p) *What MSD management process must I implement for an employee who experiences an MSD incident in a job that meets the Action Trigger?*

(1) You must provide the employee with prompt and effective MSD management at no cost to the employee. MSD management must include:

(i) Access to a Health Care Professional (HCP);

(ii) Any necessary work restrictions, including time off work to recover;

(iii) Work restriction protection; and

(iv) Evaluation and follow-up of the MSD incident.

(2) You must obtain a written opinion from the HCP for each evaluation conducted under this standard, and provide a copy to the employee. You must instruct the HCP that the opinion may not include any findings or information that is not related to workplace exposure to risk factors, and that the HCP may not communicate such information to the employer, except when authorized to do so by State or Federal law.

(3) Whenever an employee consults an HCP for MSD management, you must provide the HCP with the following:

(i) A description of the employee's job and information about the physical work activities, risk factors and MSD hazards in the job;

(ii) A copy of this standard; and

(iii) A list of information that the HCP's opinion must contain.

Note to paragraph (p): MSD management under this standard does not include medical treatment, emergency or post-treatment procedures.

(q) *What information must the HCP's opinion contain?* The HCP's opinion must contain:

(1) The HCP's assessment of the employee's medical condition as related to the physical work activities, risk factors and MSD hazards in the employee's job;

(2) Any recommended work restrictions, including, if necessary, time off work to recover, and any follow-up needed;

(3) A statement that the HCP has informed the employee of the results of the evaluation, the process to be followed to effect recovery, and any medical conditions associated with exposure to physical work activities, risk factors and MSD hazards in the employee's job; and

(4) A statement that the HCP has informed the employee about work-related or other activities that could impede recovery from the injury.

(r) *What must I do if temporary work restrictions are needed?*

(1) If an employee experiences an MSD incident in a job that meets the Action Trigger, you must provide the employee with any temporary work restrictions or time off work that the HCP determines to be necessary, or if no HCP was consulted, that you determine to be necessary.

(2) Whenever you place limitations on the work activities of the employee in his or her current job or transfer the employee to a temporary alternative duty job in accordance with paragraph (r)(1) of this section, you must provide that employee with Work Restriction Protection, which maintains the employee's employment rights and benefits, and 100% of his or her earnings, until the earliest of the following three events occurs:

(i) The employee is able to resume the former work activities without endangering his or her recovery; or

(ii) An HCP determines, subject to the determination review provisions in paragraph (s) of this section, that the employee can never resume his or her former work activities; or

(iii) 90 calendar days have passed.

(3) Whenever an employee must take time off from work in accordance with paragraph (r)(1) of this section, you must provide that employee with Work Restriction Protection, which maintains the employee's employment rights and benefits and at least 90% of his or her earnings until the earliest of the following three events occurs:

(i) The employee is able to return to the former job without endangering his or her recovery;

(ii) An HCP determines, subject to the determination review provisions in paragraph (s) of this section, that the employee can never return to the former job; or

(iii) 90 calendar days have passed.

(4) You may condition the provision of WRP on the employee's participation in the MSD management that this standard requires.

(5) Your obligation to provide WRP benefits to a temporarily restricted or removed employee is reduced to the extent that the employee receives compensation for earnings lost during the work restriction period from either a publicly or an employer-funded compensation or insurance program, or receives income from employment made possible by virtue of the employee's work restriction.

Note to paragraph (r): The employer may fulfill the obligation to provide work restriction protection benefits for employees temporarily removed from work by allowing the employees to take sick leave or other similar paid leave (*e.g.,* short-term disability leave), provided that such leave maintains the worker's benefits and employment rights and provides at least 90% of the employee's earnings.

(s) *What must I do if the employee consults his or her own HCP?*

(1) If you select an HCP to make a determination about temporary work restrictions or work removal, the

employee may select a second HCP to review the first HCP's finding at no cost to the employee. If the employee has previously seen an HCP on his or her own, at his or her own expense, and received a different recommendation, he or she may rely upon that as the second opinion;

(2) If your HCP and the employee's HCP disagree, you must, within 5 business days after receipt of the second HCP's opinion, take reasonable steps to arrange for the two HCPs to discuss and resolve their disagreement;

(3) If the two HCPs are unable to resolve their disagreement quickly, you and the employee, through your respective HCPs, must, within 5 business days after receipt of the second HCP's opinion, designate a third HCP to review the determinations of the two HCPs, at no cost to the employee;

(4) You must act consistently with the determination of the third HCP, unless you and the employee reach an agreement that is consistent with the determination of at least one of the HCPs;

(5) You and the employee or the employee's representative may agree on the use of any expeditious alternative dispute resolution mechanism that is at least as protective of the employee as the review procedures in paragraph (s) of this section.

(t) *What training must I provide to employees in my establishment?*

(1) You must provide initial training, and follow-up training every 3 years, for:

(i) Each employee in a job that meets the Action Trigger;

(ii) Each of their supervisors or team leaders; and

(iii) Other employees involved in setting up and managing your ergonomics program.

(2) The training required for each employee and each of their supervisors or team leaders must address the following topics, as appropriate:

(i) The requirements of the standard;

(ii) Your ergonomics program and the employee's role in it;

(iii) The signs and symptoms of MSDs and ways of reporting them;

(iv) The risk factors and any MSD hazards in the employee's job, as identified by the Basic Screening Tool in Table W–1 and the job hazard analysis;

(v) Your plan and timetable for addressing the MSD hazards identified;

(vi) The controls used to address MSD hazards; and

(vii) Their role in evaluating the effectiveness of controls .

(3) The training for each employee involved in setting up and managing the ergonomics program must address the following:

(i) Relevant topics in paragraph (t)(2) of this section;

(ii) How to set up, manage, and evaluate an ergonomics program;

(iii) How to identify and analyze MSD hazards and select and evaluate measures to reduce the hazards.

(4) You must provide initial training to:

(i) Each employee involved in setting up and managing your ergonomics program within 45 days after you have determined that the employee's job meets the Action Trigger;

(ii) Each current employee, supervisor and team leader within 90 days after you determine that the employee's job meets the Action Trigger;

(iii) Each new employee or current employee prior to starting a job that you have already determined meets the Action Trigger;

(5) You do not have to provide initial training in a topic that this standard requires to an employee who has received training in that topic within the previous 3 years.

(6) You must provide the training required by paragraph (t) of this section in language that the employee understands. You must also give the employee an opportunity to ask questions about your ergonomics program and the content of the training and receive answers to those questions.

(u) *What must I do to make sure my ergonomics program is effective?*

(1) You must evaluate your ergonomics program at least every 3 years as follows:

(i) Consult with your employees in the program, or a sample of those employees, and their representatives about the effectiveness of the program and any problems with the program;

(ii) Review the elements of the program to ensure they are functioning effectively;

(iii) Determine whether MSD hazards are being identified and addressed; and

(iv) Determine whether the program is achieving positive results, as demonstrated by such indicators as reductions in the number and severity of MSDs, increases in the number of problem jobs in which MSD hazards have been controlled, reductions in the number of jobs posing MSD hazards to employees, or any other measure that demonstrates program effectiveness.

(2) You must also evaluate your program, or a relevant part of it, when you have reason to believe that the program is not functioning properly.

(3) If your evaluation reveals deficiencies in your program, you must promptly correct the deficiencies.

Note to paragraph (u): The occurrence of an MSD incident in a problem job does not in itself mean that the program is ineffective.

(v) *What is my recordkeeping obligation?*

(1) If you have 11 or more employees, including part-time or temporary employees, you must keep written or electronic records of the following:

(i) Employee reports of MSDs, MSD signs and symptoms, and MSD hazards,

(ii) Your response to such reports,

(iii) Job hazard analyses,

(iv) Hazard control measures,

(v) Quick fix process,

(vi) Ergonomics program evaluations, and

(vii) Work restrictions, time off of work, and HCP opinions.

(2) You must provide all records required by this standard, other than the HCP opinions, upon request, for examination and copying, to employees, their representatives, the Assistant Secretary and the Director in accordance with the procedures and time periods provided in § 1910.1020(e)(1), (e)(2)(i), (e)(3), and (f).

(3) You must provide the HCP opinion required by this standard, upon request, for examination and copying, to the employee who is the subject of the opinion, to anyone having the specific written consent of the employee, and to the Assistant Secretary and the Director in accordance with the procedures and time periods provided in § 1910.1020(e)(1), (e)(2)(ii), (e)(3), and (f).

(4) You must keep all records for 3 years or until replaced by updated records, whichever comes first, except the HCP's opinion, which you must keep for the duration of the employee's employment plus 3 years.

(5) You do not have to retain the HCP opinion beyond the term of an employee's employment if the employee has worked for less than one year and if you provide the employee with the records at the end of his or her employment.

(w) *When does this standard become effective?* This standard becomes effective January 16, 2001.

(x) *When must I comply with the provisions of the standard?*

(1) You must provide the information in paragraph (d) of this section to your employees by October 15, 2001. After that date you must respond to employee reports of MSDs and signs and symptoms of MSDs.

(2) You must meet the time frames shown in Table W–2 for the other requirements of this section, when you have determined that an employee has experienced an MSD incident, in accordance with paragraph (e) of this section.

TABLE W–2.—COMPLIANCE TIME FRAMES

Requirements and related recordkeeping	Time frames
Paragraph (e), (f): Determination of Action Trigger	Within 7 calendar days after you determine that the employee has experienced an MSD incident.
Paragraphs (p), (q), (r), (s): MSD Management	Initiate within 7 calendar days after you determine that a job meets the Action Trigger.
Paragraphs (h) & (i): Management Leadership and Employee Participation.	Initiate within 30 calendar days after you determine that a job meets the Action Trigger.
Paragraph (t)(4)(i): Train Employees involved in setting up and managing your ergonomics program.	Within 45 calendar days after you determine that a job meets the Action Trigger.
Paragraph (j): Job Hazard Analysis	Initiate within 60 calendar days after you determine that a job meets the Action Trigger.
Paragraph (m)(2): Implement Initial Controls	Within 90 calendar days after you determine that a job meets the Action Trigger
Paragraph (t)(5)(ii): Train current employees, supervisors or team leaders.	Within 90 calendar days after you determine that the employee's job meets the Action Trigger.
Paragraph (m)(3): Implement Permanent Controls	Within 2 years after you determine that a job meets the Action Trigger, except that initial compliance can take up to January 18, 2005 whichever is later.
Paragraph (u): Program Evaluation	Within 3 years after you determine that a job meets the Action Trigger.

Note to paragraph (x): Refer to paragraph (o) of this section for Quick Fix timeframes.

(y) *When may I discontinue my ergonomics program for a job?* You may discontinue your ergonomics program for a job, except for maintaining controls and training related to those controls, if you have reduced exposure to the risk factors in that job to levels below those described in the Basic Screening Tool in Table W–1.

(z) *Definitions.* The following definitions apply to this standard:

Administrative controls are changes in the way that work in a job is assigned or scheduled that reduce the magnitude, frequency or duration of exposure to ergonomic risk factors. Examples of administrative controls for MSD hazards include:

(1) Employee rotation;

(2) Job task enlargement;

(3) Alternative tasks;

(4) Employer-authorized changes in work pace.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, or designated representative.

Control MSD Hazards: means to reduce MSD hazards to the extent that they are no longer reasonably likely to cause MSDs that result in work restrictions or medical treatment beyond first aid.

Director means the Director of the National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or designated representative.

Employee representative means, where appropriate, a recognized or certified collective bargaining agent.

Engineering controls are physical changes to a job that reduce MSD hazards. Examples of engineering controls include changing or redesigning workstations, tools, facilities, equipment, materials, or processes.

Follow-up means the process or protocol an employer or HCP uses to check on the condition of an employee after a work restriction is imposed on that employee.

Health care professionals (HCPs) are physicians or other licensed health care professionals whose legally permitted scope of practice (*e.g.,* license, registration or certification) allows them to provide independently or to be delegated the responsibility to carry out some or all of the MSD management requirements of this standard.

Job means the physical work activities or tasks that an employee performs. This standard considers jobs to be the same if they involve the same physical work activities or tasks, even if the jobs have different titles or classifications.

Musculoskeletal disorder (MSD) is a disorder of the muscles, nerves, tendons, ligaments, joints, cartilage, blood vessels, or spinal discs. For purposes of this standard, this definition only includes MSDs in the following areas of the body that have been associated with exposure to risk factors: neck, shoulder, elbow, forearm, wrist, hand, abdomen (hernia only), back, knee, ankle, and foot. MSDs may include muscle strains and tears, ligament sprains, joint and tendon inflammation, pinched nerves, and spinal disc degeneration. MSDs include such medical conditions as: low back pain, tension neck syndrome, carpal tunnel syndrome, rotator cuff syndrome, DeQuervain's syndrome, trigger finger, tarsal tunnel syndrome, sciatica, epicondylitis, tendinitis, Raynaud's phenomenon, hand-arm vibration syndrome (HAVS), carpet layer's knee, and herniated spinal disc. Injuries arising from slips, trips, falls, motor vehicle accidents, or similar accidents are not considered MSDs for the purposes of this standard.

MSD hazard means the presence of risk factors in the job that occur at a magnitude, duration, or frequency that is reasonably likely to cause MSDs that result in work restrictions or medical treatment beyond first aid.

MSD incident means an MSD that is work-related, and requires medical treatment beyond first aid, or MSD signs or MSD symptoms that last for 7 or more consecutive days after the employee reports them to you.

MSD signs are objective physical findings that an employee may be developing an MSD. Examples of MSD signs are:

(1) Decreased range of motion;

(2) Deformity;

(3) Decreased grip strength; and
(4) Loss of muscle function.

MSD symptoms are physical indications that an employee may be developing an MSD. For purposes of this Standard, MSD symptoms do not include discomfort. Examples of MSD symptoms are:

(1) Pain;
(2) Numbness;
(3) Tingling;
(4) Burning;
(5) Cramping; and
(6) Stiffness.

Personal protective equipment (PPE) is equipment employees wear that provides a protective barrier between the employee and an MSD hazard. Examples of PPE are vibration-reduction gloves and carpet layer's knee pads.

Problem job means a job that the employer has determined poses an MSD hazard to employees in that job.

Risk factor means, for the purpose of this standard: force, awkward posture, repetition, vibration, and contact stress.

Work practice controls are changes in the way an employee performs the physical work activities of a job that reduce or control exposure to MSD hazards. Work practice controls involve procedures and methods for safe work. Examples of work practice controls for MSD hazards include:

(1) Use of neutral postures to perform tasks (straight wrists, lifting close to the body);
(2) Use of two-person lift teams;
(3) Observance of micro-breaks.

Work-related means that an exposure in the workplace caused or contributed to an MSD or significantly aggravated a pre-existing MSD.

Work restriction protection (WRP) means the maintenance of the earnings and other employment rights and benefits of employees who are on temporary work restrictions. Benefits include seniority and participation in insurance programs, retirement benefits and savings plans.

Work restrictions are limitations, during the recovery period, on an employee's exposure to MSD hazards. Work restrictions may involve limitations on the work activities of the employee's current job (light duty), transfer to temporary alternative duty jobs, or temporary removal from the workplace to recover. For the purposes of this standard, temporarily reducing an employee's work requirements in a new job in order to reduce muscle soreness resulting from the use of muscles in an unfamiliar way is not a work restriction. The day an employee first reports an MSD is not considered a day away from work, or a day of work restriction, even if the employee is removed from his or her regular duties for part of the day.

You means the employer as defined by the Occupational Safety and Health Act of 1970 (29 U.S.C. 651 *et seq.*)

Appendices to § 1910.900

Non-Mandatory Appendix A to §1910.900: What You Need To Know About Musculoskeletal Disorders (MSDs)

Ergonomics is the science of fitting jobs to the people who work in them. The goal of an ergonomics program is to reduce work-related musculoskeletal disorders (MSDs) developed by workers when a major part of their jobs involve reaching, bending over, lifting heavy objects, using continuous force, working with vibrating equipment and doing repetitive motions.

What are signs and symptoms of MSDs that you should watch out for?
Workers suffering from MSDs may experience less strength for gripping, less range of motion, loss of muscle function and inability to do everyday tasks. Common symptoms include:

Painful joints
Pain, tingling or numbness in hands or feet
Shooting or stabbing pains in arms or legs
Swelling or inflammation
Burning sensation
Pain in wrists, shoulders, forearms, knees
Fingers or toes turning white
Back or neck pain
Stiffness

What are MSDs?
MSDs are injuries and illnesses that affect muscles, nerves, tendons, ligaments, joints or spinal discs. Your doctor might tell you that you have one of the following common MSDs.

Carpal tunnel syndrome
Trigger finger
Tendinitis
Herniated spinal disc
Tension neck syndrome
Rotator cuff syndrome
Sciatica
Raynaud's phenomenon
Low back pain
De Quervain's disease
Epicondylitis
Carpet layers' knee
Hand-arm Vibration Syndrome

If you have signs or symptoms of MSDs......

If MSD signs and symptoms are not reported early, permanent disability may result. It is important that you report MSD signs and symptoms right away to avoid long-lasting problems. Your employer is required to respond promptly to those reports. Contact the following person to report MSDs, MSD signs or symptoms or MSD hazards:

Name **Phone**

What causes MSDs?
Workplace MSDs are caused by exposure to the following risk factors:

Repetition. Doing the same motions over and over again places stress on the muscles and tendons. The severity of risk depends on how often the action is repeated, the speed of the movement, the number of muscles involved and the required force.

Forceful Exertions. Force is the amount of physical effort required to perform a task (such as heavy lifting) or to maintain control of equipment or tools. The amount of force depends on the type of grip, the weight of an object, body posture, the type of activity and the duration of the task.

Awkward Postures. Posture is the position your body is in and affects muscle groups that are involved in physical activity. Awkward postures include repeated or prolonged reaching, twisting, bending, kneeling, squatting, working overhead with your hands or arms, or holding fixed positions.

Contact Stress. Pressing the body against a hard or sharp edge can result in placing too much pressure on nerves, tendons and blood vessels. For example, using the palm of your hand as a hammer can increase your risk of suffering an MSD.

Vibration. Operating vibrating tools such as sanders, grinders, chippers, routers, drills and other saws can lead to nerve damage.

What is the OSHA Ergonomics Standard?

OSHA's standard requires employers to respond to employee reports of work-related MSDs or signs and symptoms of MSDs that last seven days after you report them. If your employer determines that your MSD, or MSD signs or symptoms, can be connected to your job, your employer must provide you with an opportunity to contact a health care professional and receive work restrictions, if necessary. Your wages and benefits must be protected for a period of time while on light duty or temporarily off work to recover. Your employer must analyze the job and if MSD hazards are found, must take steps to reduce those hazards.

Your employer is required to make available a summary of the OSHA ergonomics standard. The full standard can be found at http://www.osha.gov.

- **Talk to your supervisor or other responsible persons about your suggestions on how to fix the problem.**

- **Your employer may not discriminate against you for reporting MSDs, MSD signs or symptoms or MSD hazards. Your employer may not have policies that discourage such reporting.**

Non-Mandatory Appendix B to § 1910. 900: Summary of the OSHA Ergonomics Program Standard

1. Why did OSHA issue an Ergonomics Program Standard?

OSHA has issued an ergonomics standard to reduce musculoskeletal disorders (MSDs) developed by workers whose jobs involve repetitive motions, force, awkward postures, contact stress and vibration. The principle behind ergonomics is that by fitting the job to the worker through adjusting a workstation, rotating between jobs or using mechanical assists, MSDs can be reduced and ultimately eliminated.

2. Who is covered by the standard?

All general industry employers are required to abide by the rule. The standard does not apply to employers whose primary operations are covered by OSHA's construction, maritime or agricultural standards, or employers who operate a railroad.

3. What does the rule require employers to do?

The rule requires employers to inform workers about common MSDs, MSD signs and symptoms and the importance of early reporting. When a worker reports signs or symptoms of an MSD, the employer must determine whether the injury meets the definition of an MSD incident—a work-related MSD that requires medical treatment beyond first aid, assignment to a light duty job or temporary removal from work to recover, or work-related MSD signs or MSD symptoms that last for seven or more consecutive days.

If it is an MSD Incident, the employer must check the job, using a Basic Screening Tool to determine whether the job exposes the worker to risk factors that could trigger MSD problems. The rule provides a Basic Screening Tool that identifies risk factors that could lead to MSD hazards. If the risk factors on the job meet the levels of exposure in the Basic Screening Tool, then the job will have met the standard's Action Trigger.

4. What happens when the worker's job meets the standard's Action Trigger?

If the job meets the Action Trigger, the employer must implement the following program elements:

A. Management Leadership and Employee Participation: The employer must set up an MSD reporting and response system and an ergonomics program and provide supervisors with the responsibility and resources to run the program. The employer must also assure that policies encourage and do not discourage employee participation in the program, or the reporting of MSDs, MSD signs and symptoms, and MSD hazards.

Employees and their representatives must have ways to report MSDs, MSD signs and symptoms and MSD hazards in the workplace, and receive prompt responses to those reports. Employees must also be given the opportunity to participate in the development, implementation, and evaluation of the ergonomics program.

B. Job Hazard Analysis and Control: If a job meets the Action Trigger, the employer must conduct a job hazard analysis to determine whether MSD hazards exist in the job. If hazards are found, the employer must implement control measures to reduce the hazards. Employees must be involved in the identification and control of hazards.

C. Training: The employer must provide training to employees in jobs that meet the Action Trigger, their supervisors or team leaders and other employees involved in setting up and managing your ergonomics program.

D. MSD Management: Employees must be provided, at no cost, with prompt access to a Health Care Professional (HCP), evaluation and follow-up of an MSD incident, and any temporary work restrictions that the employer or the HCP determine to be necessary. Temporary work restrictions include limitations on the work activities of the employee in his or her current job, transfer of the employee to a temporary alternative duty job, or temporary removal from work.

E. Work Restriction Protection: Employers must provide Work Restriction Protection (WRP) to employees who receive temporary work restrictions. This means maintaining 100% of earnings and full benefits for employees who receive limitations on the work activities in their current job or transfer to a temporary alternative duty job, and 90% of earnings and full benefits to employees who are removed from work. WRP is good for 90 days, or until the employee is able to safely return to the job, or until an HCP determines that the employee is too disabled to ever return to the job, whichever comes first.

F. Second Opinion: The standard also contains a process permitting the employee to use his or her own HCP as well as the employer's HCP to determine whether work restrictions are required. A third HCP may be chosen by the employee and the employer if the first two disagree.

G. Program Evaluation: The employer must evaluate the ergonomics program to make sure it is effective. The employer must ask employees what they think of it, check to see if hazards are being addressed, and make any necessary changes.

H. Recordkeeping: Employers with 11 or more employees, including part-time employees, must keep written or electronic records of employee reports of MSDs, MSD signs and symptoms and MSD hazards, responses to such reports, job hazard analyses, hazard control measures, ergonomics program evaluations, and records of work restrictions and the HCP's written opinions. Employees and their representatives must be provided access to these records.

I. Dates: Employers must begin to distribute information, and receive and respond to employee reports by October 15, 2001. Employers must implement permanent controls by November 14, 2004 or two years following determination that a job meets the Action Trigger, whichever comes later. Initial controls must be implemented within 90 days after the employer determines that the job meets the Action Trigger. Other obligations are triggered by the employer's determination that the job has met the Action Trigger.

5. Flexibility features of the Ergonomics Program Standard:

A. Employers whose workers have experienced a few isolated MSDs may be able to use the "Quick Fix" option to reduce hazards and avoid implementing many parts of the program.

B. Employers who already have ergonomics programs may be able to "grandfather" existing programs.

C. The employer may discontinue parts of the program under certain conditions.

The full OSHA Ergonomics Standard can be found at *http://www.osha.gov.*

Appendix C to § 1910.900 [Reserved]

Appendix D to § 1910.900: Hazard Identification Tools

Appendix D to § 1910.900 contains hazard identification tools. This appendix consists of Appendix D–1, Ergonomics Job Hazard Analysis Tools, and Appendix D–2, VDT Workstation Checklist.

Appendix D–1 to § 1910.900: Ergonomics Job Hazard Analysis Tools (Mandatory)

Paragraph (j)(3)(i) of the OSHA Ergonomics Program Standard allows employers to use any of the job hazard analysis tools in this appendix, where appropriate to the risk factors in the job, to fulfill their obligations to conduct a job hazard analysis (paragraph (j)(3)) and reduce MSD hazards (paragraphs (k) and (m)). This mandatory appendix contains important information about these tools. A description of each of these tools is also contained in the Summary and Explanation of paragraph (j) in the preamble to this standard.

BILLING CODE 4510–26–P

JOB HAZARD ANALYSIS TOOLS

JOB HAZARD ANALYSIS TOOLS	SOURCE *	RISK FACTORS EVALUATED	AREAS OF BODY ADDRESSED	EXAMPLES OF JOBS TOOL APPLIES TO
Job Strain Index	"The Strain Index: A Proposed Method to Analyze Jobs For Risk of Distal Upper Extremity Disorders." Moore, J.S., and Garg, A, 1995; *AIHA Journal*, 56(5): 443–458. You may obtain a copy from: American Industrial Hygienists Association. 2700 Prosperity Ave Suite 250 Fairfax, VA 22031. Phone: (703) 849-8888 Web site: http://www.aiha.org/ See also: http://sg-www.satx.disa.mil/hscoemo/tools/strain.htm for a Web-based version of this tool.	• Repetition • Force • Awkward postures	• Hands • Wrists	• Small parts assembly • Inspecting • Meatpacking • Sewing • Packaging • Keyboarding • Data Processing • Jobs involving highly repetitive hand motions

JOB HAZARD ANALYSIS TOOLS

Revised NIOSH Lifting Equation	*Applications Manual for the Revised NIOSH Lifting Equation*, Waters, T.R., Putz-Anderson, V., Garg, A., National Institute for Occupational Safety and Health, January 1994 (DHHS, NIOSH Publication No. 94-110). You may obtain a copy from: U.S. Department of Commerce Technology Administration National Technical Information Service (NTIS) 5285 Port Royal Road Springfield, VA 22161 (NTIS Publication No. PB94-176930) Phone: (703) 487-4650 Web site: http://www.cdc.gov/niosh/ See also: http://www.industrialhygiene.com/calc/lift.html for a Web-based version of this tool.	• Repetition • Force • Awkward postures	• Lower back	• Package sorting, handling • Package delivery • Beverage delivery • Assembly work • Manual handling involving lifting weights >10 Lbs. • Production jobs involving forceful exertions • Stationary lifting

JOB HAZARD ANALYSIS TOOLS

Snook Push/Pull Hazard Tables	"The Design of Manual Handling Tasks: Revised Tables of Maximum Acceptable Weights and Forces," Snook, S.H. and Ciriello, V.M., *Ergonomics*, 1991, 34(9): 1197-1213. You may obtain a copy from: Taylor & Francis Inc. 325 Chestnut Street Suite 800 Philadelphia, PA 19106, USA Phone: (800) 354-1420 Web site: http://www.tandf.co.uk/journals/	• Repetition • Force • Awkward postures	• Back • Trunk • Shoulders • Legs	• Food service • Laundry • Housekeeping • Janitorial • Package delivery • Garbage collection • Nursing homes • EMT, ambulance • Jobs involving pushing/pulling carts • Jobs involving carrying objects
Rapid Upper Limb Assessment (RULA)	"RULA: A Survey Method for the Investigation of Work-Related Upper Limb Disorders," McAtamney, L. and Corlett, E.N., *Applied Ergonomics*, 1993, 24(2): 91-99. You may obtain a copy from: Elsevier Science Regional Sales Office Customer Support Department P.O. Box 945 New York, N.Y. 10159 Phone: (212) 633-3730 Web site: http://www.elsevier.com/	• Repetition • Force • Awkward postures	• Wrists • Forearms • Elbows • Shoulders • Neck • Trunk	• Assembly work • Production work • Sewing • Janitorial • Maintenance • Meatpacking • Grocery cashier • Telephone operator • Ultrasound technicians • Dentists • Dental technicians

JOB HAZARD ANALYSIS TOOLS

Rapid Entire Body Assessment (REBA)	"Rapid Entire Body Assessment (REBA)," Hignett, S. and McAtamney, L., *Applied Ergonomics*, 2000, 31: 201-205. You may obtain a copy from: Elsevier Science Regional Sales Office Customer Support Department P.O. Box 945 New York, N.Y. 10159 Phone: (212) 633-3730 Web site: http://www.elsevier.com/	• Repetition • Force • Awkward postures	• Wrists • Forearms • Elbows • Shoulders • Neck • Trunk • Back • Legs • Knees	• Patient lifting, transfer • Nurses • Nurses aides • Orderlies • Janitors • Housekeeping • Grocery warehouse • Grocery cashier • Telephone operator • Ultrasound technicians • Dentists • Dental technicians • Veterinarian

JOB HAZARD ANALYSIS TOOLS				
ACGIH Hand/Arm (Segmental) Vibration TLV	1998 Threshold Limit Values for Physical Agents in the Work Environment, *1998 TLVs® and BEIs® Threshold Limit Values for Chemical Substances and Physical Agents Biological Exposure Indices*, pp. 109-131, American Conference of Governmental Industrial Hygienists. You may obtain a copy from: American Conference of Governmental Industrial Hygienists, Inc. 1330 Kemper Meadow Dr. Suite 600 Cincinnati, OH 45240 Phone: (513) 742-2020 Web site: http://www.acgih.org/	• Vibration	• Hands • Arms • Shoulders	• Grinding • Sanding • Chipping • Drilling • Sawing • Jigsawing • Chainsawing • Production work using vibrating or power hand tools • Regular use of vibrating hand tools
GM-UAW Risk Factor Checklist	"UAW-GM Ergonomics Risk Factor Checklist RFC2," United Auto Workers-General Motors Center for Human Resources, Health and Safety Center, 1998. You may obtain a copy from: UAW-GM Center for Human Resources Health and Safety Center 1030 Doris Road Auburn Hills, MI 48326	• Repetition • Force • Awkward postures • Contact stress • Vibration	• Hands • Wrists • Forearms • Elbows • Shoulders • Neck • Trunk • Back • Legs • Knees	• Assembly work • Production work • Small parts assembly

JOB HAZARD ANALYSIS TOOLS

Washington State Appendix B	WAC 296-62-05174, "Appendix B: Criteria for analyzing and reducing WMSD hazards for employers who choose the Specific Performance Approach," Washington State Department of Labor and Industries, May 2000. You may obtain a copy from: Washington Department of Labor and Industries PO Box 44001 Olympia, Washington 98504 Phone: (360) 902-4200 Web site: http://www.lni.wa.gov/wisha/	• Repetition • Force • Awkward postures • Contact stress • Vibration	• Hands • Wrists • Forearms • Elbows • Shoulders • Neck • Trunk • Back • Legs • Knees	• Assembly work • Production work • Sewing • Meatpacking • Keyboarding • Data processing • Small parts assembly • Maintenance • Patient lifting • Package delivery • Package sorting • Garbage collection • Food service • Regular use of vibrating hand tools

Appendix D-1 to §1910.900 incorporates the documents in this column by reference. The Director of the Federal Register approves this incorporation by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. You may inspect a copy of any of these documents at the Occupational Safety and Health Administration, Technical Data Center, Room N2625, 200 Constitution Ave., N.W., Washington, DC, 20210, or at the Office of the Federal Register, 800 North Capitol Street, NW., Suite 700, Washington, DC.

Appendix D-2 to §1910.900: VDT Workstation Checklist

Using this checklist is one, but not the only, way an employer can comply with the requirement to identify, analyze and control MSD hazards in VDT tasks. This checklist does not require that employees assume specific working postures in order for the employer to be in compliance. Rather, employers will be judged to be in compliance with paragraph (k) and (m) of OSHA's standard if they provide the employee with a VDT workstation is arranged or designed in a way that would pass this checklist.

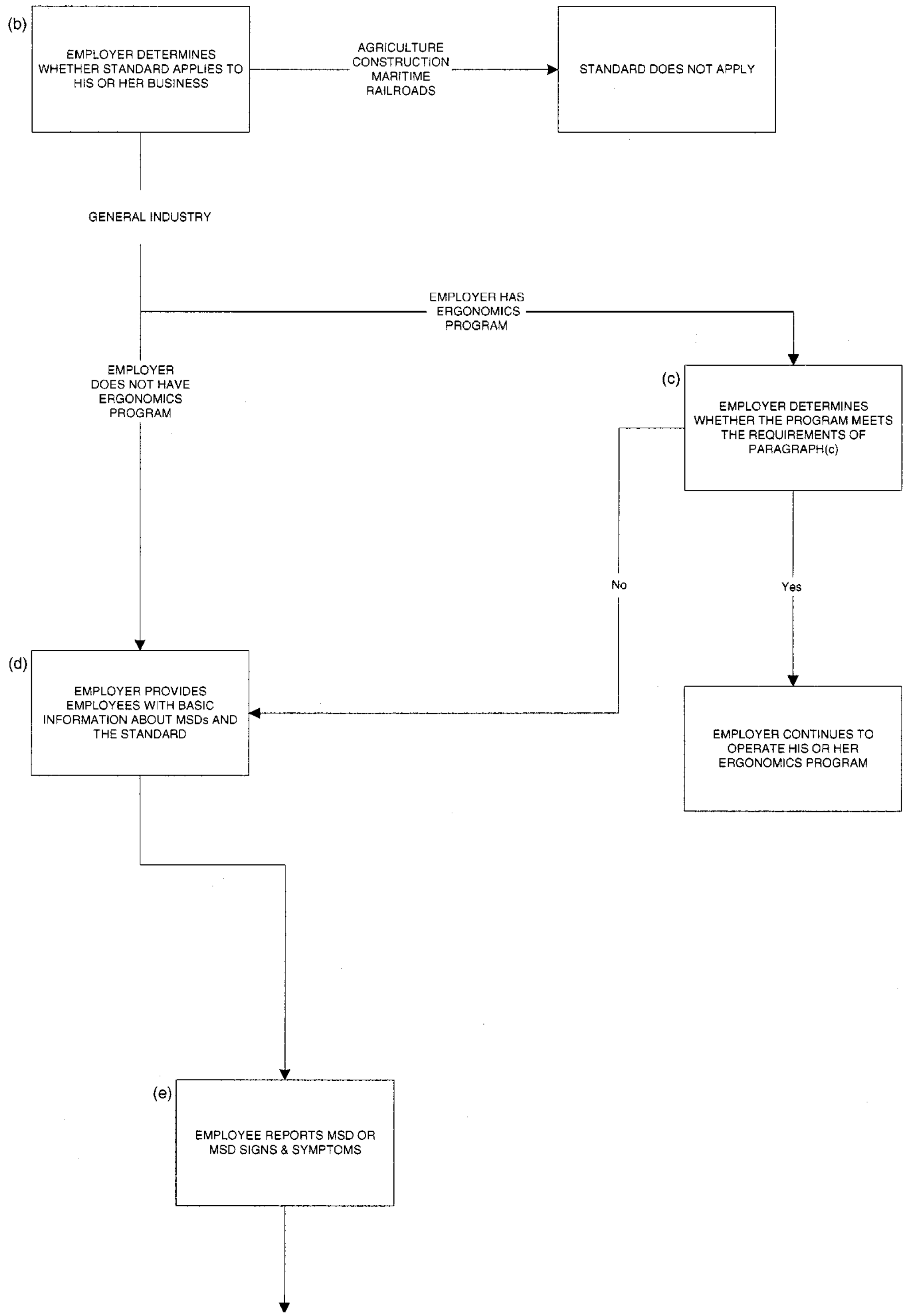
If employee exposure does not meet the levels indicated by the Basic Screening Tool, you may STOP HERE.

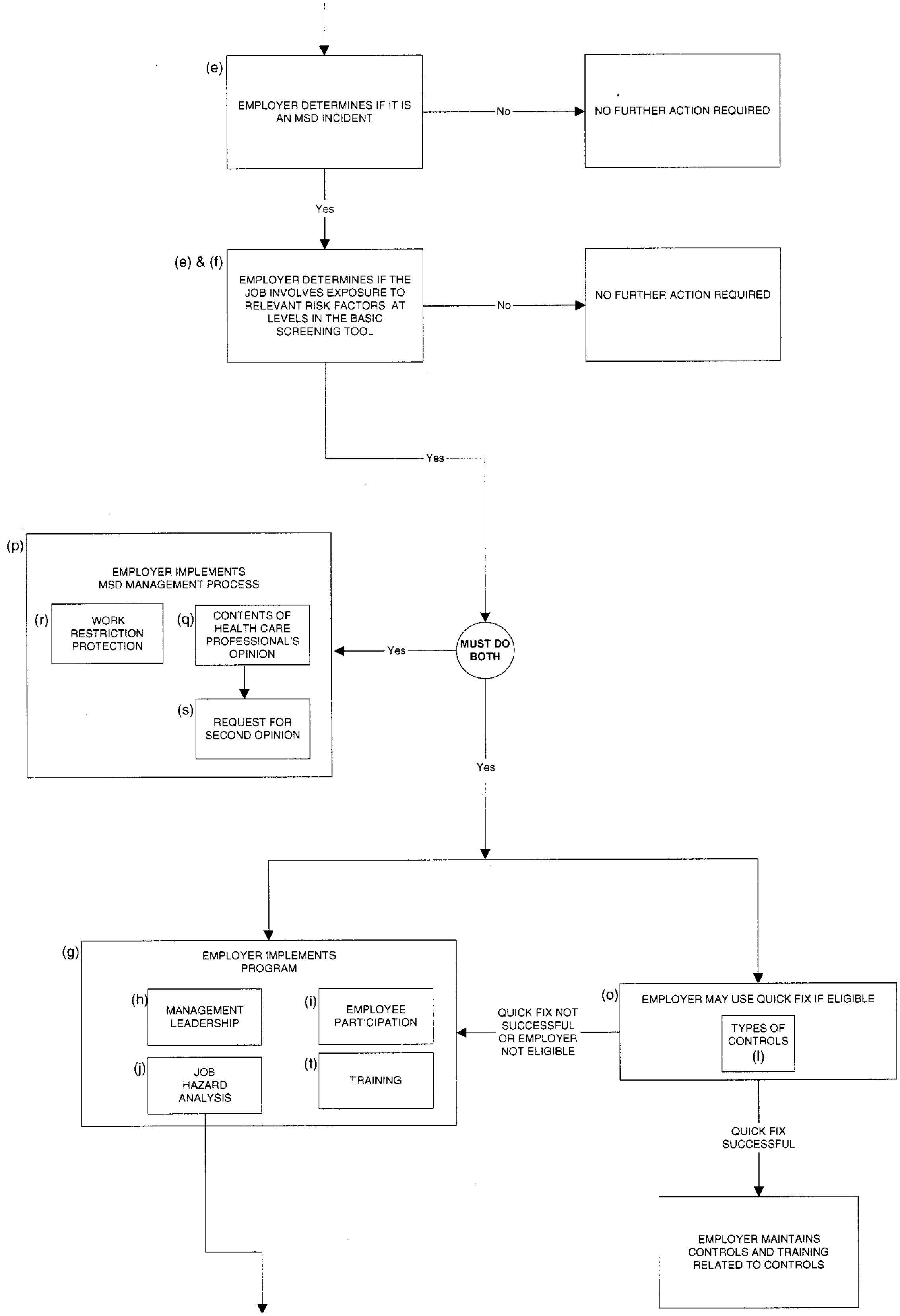
WORKING CONDITIONS **The workstation is designed or arranged for doing VDT tasks so it allows the employee's . . .**	**Y**	**N**
A. Head and **neck** to be about upright (not bent down/back).		
B. Head, neck and **trunk** to face forward (not twisted).		
C. Trunk to be about perpendicular to floor (not leaning forward/backward).		
D. Shoulders and **upper arms** to be about perpendicular to floor (not stretched forward) and relaxed (not elevated).		
E. Upper arms and **elbows** to be close to body (not extended outward).		
F. Forearms, wrists, and **hands** to be straight and parallel to floor (not pointing up/down).		
G. Wrists and **hands** to be straight (not bent up/down or sideways toward little finger).		
H. Thighs to be about parallel to floor and **lower legs** to be about perpendicular to floor.		
I. Feet to rest flat on floor or be supported by a stable footrest.		
J. VDT tasks to be organized in a way that allows employee to vary VDT tasks with other work activities, or to take micro-breaks or recovery pauses while at the VDT workstation.		
SEATING **The chair . . .**	**Y**	**N**
1. Backrest provides support for employee's lower back (lumbar area).		
2. Seat width and **depth** accommodate specific employee (seatpan not too big/small).		
3. Seat front does not press against the back of employee's knees and lower legs (seatpan not too long).		
4. Seat has cushioning and is rounded/ has "waterfall" front (no sharp edge).		
5. Armrests support both forearms while employee performs VDT tasks and do not interfere with movement.		

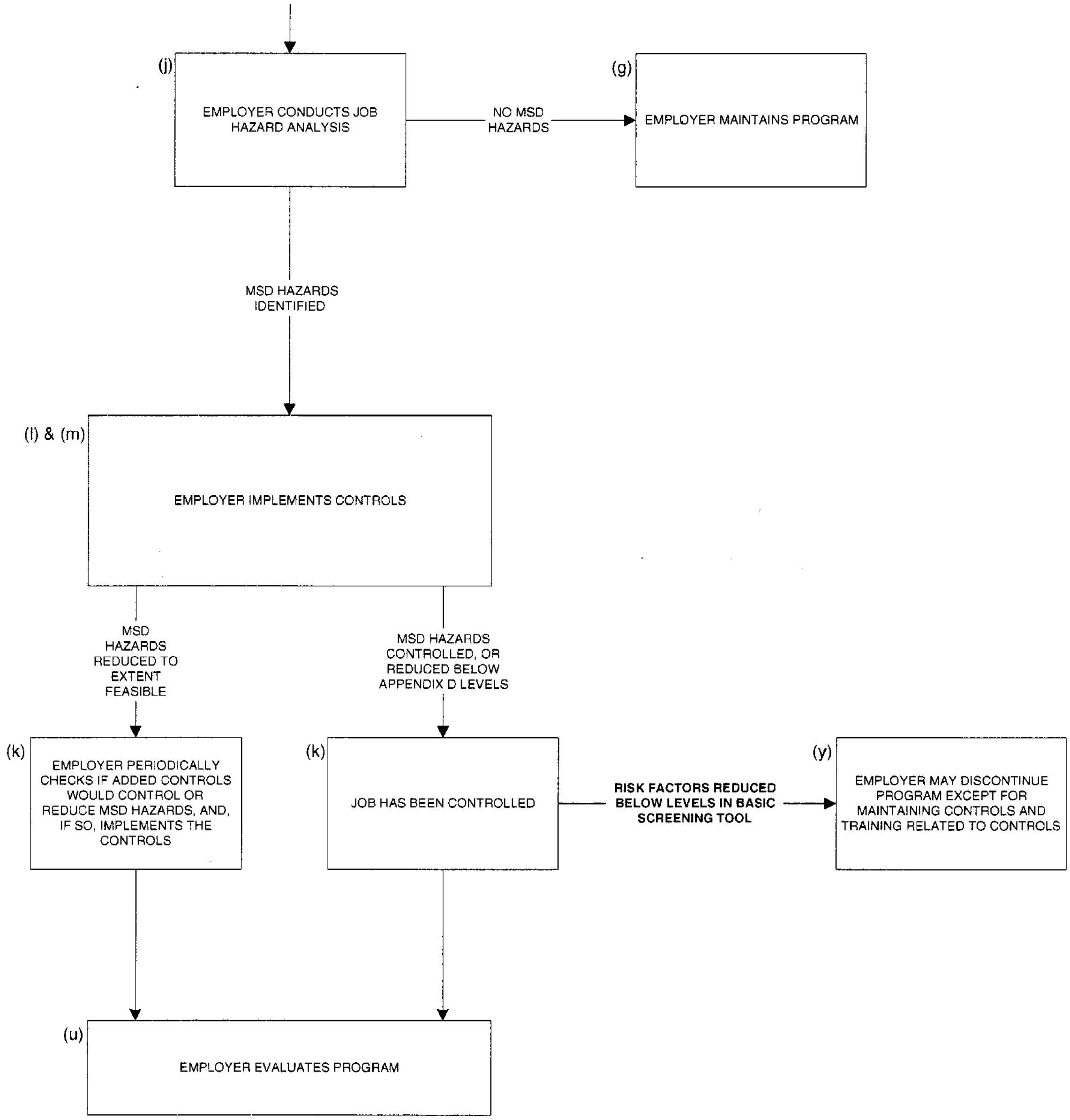
KEYBOARD/INPUT DEVICE **The keyboard/input device is designed or arranged for doing VDT tasks so that . . .**	Y	N
6. Keyboard/input device platform(s) is stable and large enough to hold keyboard and input device.		
7. Input device (mouse or trackball) is located right next to keyboard so it can be operated without reaching.		
8. Input device is easy to activate and shape/size fits hand of specific employee (not too big/small).		
9. Wrists and **hands** do not rest on sharp or hard edge.		
MONITOR **The monitor is designed or arranged for VDT tasks so that . . .**	**Y**	**N**
10 .Top line of screen is at or below eye level so employee is able to read it without bending head or neck down/back. (For employees with bifocals/trifocals, see next item.)		
11. Employee with bifocals/trifocals is able to read screen without bending head or neck backward.		
12. Monitor distance allows employee to read screen without leaning head, neck or trunk forward/backward.		
13. Monitor position is directly in front of employee so employee does not have to twist head or neck.		
14. No glare (e.g., from windows, lights) is present on the screen which might cause employee to assume an awkward posture to read screen.		
WORK AREA **The work area is designed or arranged for doing VDT tasks so that . . .**	**Y**	**N**
15. Thighs have clearance space between chair and VDT table/keyboard platform (thighs not trapped).		
16. Legs and **feet** have clearance space under VDT table so employee is able to get close enough to keyboard/input device.		
ACCESSORIES	**Y**	**N**
17. Document holder, if provided, is stable and large enough to hold documents that are used.		
18. Document holder, if provided, is placed at about the same height and distance as monitor screen so there is little head movement when employee looks from document to screen.		
19. Wrist rest, if provided, is padded and free of sharp and square edges.		
20. Wrist rest, if provided, allows employee to keep forearms, wrists and hands straight and parallel to ground when using keyboard/input device.		
21. Telephone can be used with head upright (not bent) and shoulders relaxed (not elevated) if employee does VDT tasks at the same time.		

GENERAL	Y	N
22. Workstation and equipment have sufficient adjustability so that the employee is able to be in a safe working posture and to make occasional changes in posture while performing VDT tasks.		
23. VDT Workstation, equipment and accessories are maintained in serviceable condition and function properly.		
PASSING SCORE = "YES" answer on all "working postures" items (A-J) and no more than two "NO" answers on remainder of checklist (1-23).		

APPENDIX E
ERGONOMICS RULE FLOW CHART*
(RELEVANT PARAGRAPH SHOWN IN PARENTHESES)




(e)
EMPLOYER DETERMINES IF IT IS AN MSD INCIDENT
No
NO FURTHER ACTION REQUIRED
Yes
(e) & (f)
EMPLOYER DETERMINES IF THE JOB INVOLVES EXPOSURE TO RELEVANT RISK FACTORS AT LEVELS IN THE BASIC SCREENING TOOL
No
NO FURTHER ACTION REQUIRED
Yes
(p)
EMPLOYER IMPLEMENTS MSD MANAGEMENT PROCESS
(r)
WORK RESTRICTION PROTECTION
(q)
CONTENTS OF HEALTH CARE PROFESSIONAL'S OPINION
(s)
REQUEST FOR SECOND OPINION
Yes
MUST DO BOTH
Yes
(g)
EMPLOYER IMPLEMENTS PROGRAM
(h)
MANAGEMENT LEADERSHIP
(i)
EMPLOYEE PARTICIPATION
(j)
JOB HAZARD ANALYSIS
(t)
TRAINING
QUICK FIX NOT SUCCESSFUL OR EMPLOYER NOT ELIGIBLE
(o)
EMPLOYER MAY USE QUICK FIX IF ELIGIBLE
TYPES OF CONTROLS (l)
QUICK FIX SUCCESSFUL
EMPLOYER MAINTAINS CONTROLS AND TRAINING RELATED TO CONTROLS



* Employers with 11 or more employees must keep records as specified in paragraph (v).

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