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10 CFR Part 431

Energy Conservation Program: Test Procedures for Walk-In Coolers and Walk-In Freezers; Proposed Rule

DEPARTMENT OF ENERGY

10 CFR Part 431

[Docket No. EERE–2008–BT–TP–0014]

RIN 1904–AB85

Energy Conservation Program: Test Procedures for Walk-In Coolers and Walk-In Freezers

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notice of proposed rulemaking and public meeting.

SUMMARY: Pursuant to the Energy Policy and Conservation Act, as amended, the U.S. Department of Energy (DOE) is proposing test procedures for measuring the energy consumption of walk-in coolers and walk-in freezers (collectively ''walk-in equipment'' or ''walk-in(s)''), definitions to delineate the products covered by the test procedures, and provisions (including a sampling plan) for manufacturers to implement the test procedures. The notice also addresses enforcement issues as they relate to walk-in equipment. Concurrently, DOE is undertaking an energy conservation standards rulemaking for this equipment. Any data gathered through the use of the test procedure adopted by DOE will be used in evaluating any potential standards for this equipment. Once these standards are promulgated, the adopted test procedures will be used to determine equipment efficiency and compliance with the standards.

DATES: DOE will hold a public meeting in Washington, DC on Thursday, February 11, 2010, beginning at 9 a.m. DOE must receive requests to speak at the meeting before 4 p.m., Thursday, January 28, 2010. DOE must receive a signed original and an electronic copy of statements to be given at the public meeting before 4 p.m., Thursday, January 28, 2010.

DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NOPR) before or after the public meeting, but no later than March 22, 2010. See section V, ''Public Participation,'' of this NOPR for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E–089, 1000 Independence Avenue, SW., Washington, DC 20585–0121. To attend the public meeting, please notify Ms. Brenda Edwards at (202) 586–2945. Please note that foreign nationals participating in the public meeting are subject to advance security screening procedures, requiring a 30-day advance notice. If you are a foreign national and wish to participate in the public meeting, please inform DOE as soon as possible by contacting Ms. Brenda Edwards at (202) 586–2945 so that the necessary procedures can be completed.

Any comments submitted must identify the NOPR for Test Procedures for Walk-in Coolers and Freezers, and provide docket number EERE–2008–BT–TP–0014 and/or Regulation Identifier Number (RIN) 1904–AB85. Comments may be submitted using any of the following methods:

1. *Federal eRulemaking Portal: http://www.regulations.gov*. Follow the instructions for submitting comments.
2. *E-mail: WICF-2008-TP-0014@hq.doe.gov*. Include the docket number EERE–2008–BT–TP–0014 and/or RIN 1904–AB85 in the subject line of the message.
3. *Postal Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Please submit one signed original paper copy.
4. *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza, SW., 6th Floor, Washington, DC 20024. Please submit one signed original paper copy.

For detailed instructions on submitting comments and additional information on the rulemaking process, see section V, ''Public Participation,'' of this document.

Docket: For access to the docket to read background documents or comments received, visit the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., 6th Floor, Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m. Monday through Friday, except Federal holidays. Please call Ms. Brenda Edwards at the above telephone number for additional information regarding visiting the Resource Room.

FOR FURTHER INFORMATION CONTACT: Mr. Charles Llenza, U.S. Department of Energy, Building Technologies Program, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–2192, *Charles.Llenza@ee.doe.gov* or Mr. Michael Kido, Esq., U.S. Department of Energy, Office of General Counsel, GC–72, 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–8145, *Michael.Kido@hq.doe.gov*.

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Authority and Background

Title III of the Energy Policy and Conservation Act of 1975, as amended (EPCA or the Act) sets forth a variety of provisions designed to improve energy efficiency. Part B of Title III (42 U.S.C. 6291–6309) provides for the Energy Conservation Program for Consumer Products Other Than Automobiles. The National Energy Conservation Policy Act (NECPA), Public Law 95–619, amended EPCA to add Part C of Title III, which established an energy conservation program for certain industrial equipment. (42 U.S.C. 6311–6317) (These parts were subsequently redesignated as Parts A and A–1, respectively, for editorial reasons.) Section 312 of the Energy Independence and Security Act of 2007 (EISA 2007) further amended EPCA by adding certain equipment to this energy conservation program, including walk-in coolers and walk-in freezers (collectively ''walk-in equipment'' or ''walk-ins''), the subject of this rulemaking. (42 U.S.C. 6311(1), (2), 6313(f) and 6314(a)(9))

EPCA defines walk-in equipment as follows:

(A) In general.—

The terms ''walk-in cooler'' and ''walk-in freezer'' mean an enclosed storage space refrigerated to temperatures, respectively, above, and at or below 32 degrees Fahrenheit that can be walked into, and has a total chilled storage area of less than 3,000 square feet.

(B) Exclusion.—

The terms ''walk-in cooler'' and ''walk-in freezer'' do not include products designed and marketed exclusively for medical, scientific, or research purposes. (42 U.S.C. 6311(20))

Walk-ins covered by this rulemaking may be located indoors or outdoors. They may be used exclusively for storage, but they may also have transparent doors or panels for the purpose of displaying stored items. Examples of items that may be stored in walk-ins include, but are not limited to, food, beverages, and flowers. DOE notes that any equipment that meets the above definition is potentially subject to regulation.

Under the Act, the overall program consists essentially of the following parts: testing, labeling, and Federal energy conservation standards. The testing requirements for covered equipment consist of test procedures, prescribed under EPCA. These test procedures are used in several different ways: (1) Any data from the use of these procedures are used as a basis in developing standards for covered products or equipment; (2) the test procedure is used when determining equipment compliance with those standards; and (3) manufacturers of covered equipment must use the procedure to establish that their equipment complies with energy conservation standards promulgated pursuant to EPCA and when making representations about equipment efficiency.

Section 343 of EPCA (42 U.S.C. 6314) sets forth generally applicable criteria and procedures for DOE's adoption and amendment of such test procedures. That provision requires that the test procedures promulgated by DOE be reasonably designed to produce test results which reflect energy efficiency, energy use, and estimated operating costs of the covered equipment during a representative average use cycle. It also requires that the test procedure not be unduly burdensome to conduct. See 42 U.S.C. 6314(a)(2). As part of the process for promulgating a test procedure, DOE must publish the procedure that it plans to propose and offer the public an opportunity to present oral and written comments on them. Consistent with Executive Order 12889 and EPCA (see 42 U.S.C. 6314(b)), DOE provides a minimum comment period of 75 days on a proposed test procedure. As to the test procedures for walk-in equipment, EPCA prescribes the following requirements:

(A) In general.—

For the purpose of test procedures for walk-in coolers and walk-in freezers:

(i) The R value shall be the 1/K factor multiplied by the thickness of the panel.

(ii) The K factor shall be based on ASTM [American Society for Testing and Materials] test procedure C518–2004.

(iii) For calculating the R value for freezers, the K factor of the foam at 20 °F (average foam temperature) shall be used.

(iv) For calculating the R value for coolers, the K factor of the foam at 55 °F (average foam temperature) shall be used.

(B) Test Procedure.—

(i) In general.—Not later than January 1, 2010, the Secretary shall establish a test procedure to measure the energy-use of walk-in coolers and walk-in freezers.

(ii) Computer modeling.—The test procedure may be based on computer modeling, if the computer model or models have been verified using the results of laboratory tests on a significant sample of walk-in coolers and walk-in freezers. (42 U.S.C. 6314(a)(9))

On February 4, 2009, DOE held a public meeting on the framework document it issued concerning the DOE rulemaking to evaluate walk-in equipment for energy conservation standards. See 74 FR 411 (Jan. 6, 2009) and 74 FR 1992 (Jan. 14, 2009). Both the framework document and meeting discussed the possible test procedures for this equipment that DOE was considering at that time, and gave interested parties an opportunity to submit comments. Today's notice addresses those comments and proposes test procedures for walk-in equipment.

II. Summary of the Proposal

In today's notice, DOE proposes to adopt new test procedures for determining the energy use of walk-in cooler and walk-in freezer equipment to address the statutory requirement to establish a test procedure by January 1, 2010. (42 U.S.C. 6314(a)(9)(B)) Concurrently, DOE is undertaking an energy conservation standards rulemaking for walk-in equipment to address the statutory requirement to establish performance standards no later than January 1, 2012. (42 U.S.C. 6313(f)(4)(A)) DOE will use any data resulting from use of the test procedure that DOE adopts to evaluate potential performance standards for this equipment. Furthermore, once performance standards are issued, manufacturers would be required to use the test procedures to determine compliance with such standards and for any representations regarding the energy use of walk-in equipment they produce. This test procedure, once adopted, would serve as the means for ascertaining compliance with the appropriate standards in an enforcement action.

For the reasons described below, DOE proposes to adopt a test procedure that contains two separate test methods. This approach is necessary because there are typically two manufacturers of walk-in equipment: One who manufactures the envelope (*i.e.*, the insulated box in which the refrigerated or frozen items are stored) and one who manufactures the refrigeration system (*i.e.*, the mechanism that provides the means by which to feed chilled air into the envelope). One method determines the energy consumption of the refrigeration system of the walk-in cooler or freezer. The other method determines the energy consumption of the envelope, which is the sum of the energy use associated with heat transmission through the envelope in the form of conduction through the walls and air infiltration through openings, and the power consumed by electrical components that are part of the envelope. Each of the two components, the refrigeration system and the envelope, is considered separately and the energy consumption of each component is calculated using the applicable test procedure. DOE believes that the approach is consistent with the requirements in EPCA because the results of the two tests will represent, in the aggregate, the total energy consumption of walk-in coolers and freezers.

Using this approach, DOE believes that the proposed test procedures will adequately measure the energy consumption of walk-in equipment by capturing the energy consumption of both components. However, DOE requests comment from stakeholders on improvements or changes to the proposed test procedures and will consider modifications that improve the accuracy, appropriateness for the equipment being tested, repeatability of test results for the same or similar units, comparability of results for different types of units, burden on manufacturers, precision of language, or other elements of the procedures. In submitting comments, interested parties should state the nature of the recommended modification and explain how it would improve upon the test procedure proposed in this NOPR. Commenters should also submit data, if any, to support their positions.

DOE's adoption of the proposed test procedures, which would be applicable to all walk-in equipment, would not necessarily mean that DOE would adopt a single energy conservation standard or set of labeling requirements for all walk-in equipment. In the separate rulemaking proceeding concerning energy conservation standards for walk-in equipment, DOE may divide such equipment into classes and may conclude that standards are not warranted for some classes of equipment that are within the scope of today's test procedure. Furthermore, DOE may create a separate standard for each class of equipment that includes a utility- or performance-related feature that another equipment class lacks, and that affects energy consumption.

DOE also notes that the National Technology Transfer and Advancement Act of 1995 (Pub. L. 104–113) directs Federal agencies to use voluntary consensus standards in lieu of Government standards whenever possible. Consequently, as described in the following paragraphs, DOE attempted to incorporate by reference in its test procedures generally accepted rules or recognized industry standards such as those issued by the Air-Conditioning, Heating and Refrigeration Institute (AHRI), the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), the American National Standards Institute (ANSI), and/or ASTM International (ASTM), that provide either specific aspect(s) of the test procedure, or the complete test procedure, for the specified equipment.

III. Discussion

In the following section, DOE describes the overall approach it proposes to follow with respect to the adoption of a test procedure for walk-ins. This approach results from the characteristics of walk-in equipment and is based in part on the basic model definition that DOE currently uses to help establish testing requirements for manufacturers to follow. The following section also addresses issues raised by commenters, which included: Manufacturers (Craig Industries (Craig), Manitowoc, Nor-Lake); trade associations (AHRI); utility companies (Southern California Edison (SCE), Sacramento Municipal Utility District (SMUD), San Diego Gas and Electric (SDG&E)); and advocacy groups (Appliance Standards Awareness Project (ASAP), American Council for an Energy-Efficient Economy (ACEEE), Natural Resources Defense Council (NRDC), Northwest Energy Efficiency Alliance (NEEA)).

A. Overall Approach

DOE developed today's proposed test procedure to set forth the testing requirements for walk-in equipment. In the framework document, DOE considered two overall approaches manufacturers could take to determine the energy consumption of walk-in coolers and freezers. First, DOE considered using a modified version of the Air-Conditioning and Refrigeration Institute (ARI) Standard 1200–2006, ''Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets'' (ARI 1200–2006), which uses the test method described in the American National Standards Institute/American Society of Heating, Refrigerating, and Air Conditioning Engineers (ANSI/ASHRAE) Standard 72–2005, ''Method of Testing Commercial Refrigerators and Freezers'' (ANSI/ASHRAE 72–2005). Second, DOE considered allowing manufacturers to determine the efficiency of some of their products using alternative efficiency determination methods (AEDMs). (An AEDM is a predictive mathematical model, developed from engineering analyses of design data and substantiated by actual test data, which represents the energy consumption characteristics of one or more basic models.)

DOE received comments on these proposed approaches, many of which were opposed to both approaches. The comments DOE received, and DOE's responses, are discussed in more detail below. After considering these comments and reviewing the matter further, DOE is proposing separate test procedures for the envelope (insulated box) and the refrigeration system. DOE discusses the details of its proposals and addresses manufacturer comments in the following subsections.

1. Basic Model

Under EPCA, which prohibits the distribution in commerce of covered equipment that do not comply with the applicable standard, each model of covered equipment is potentially subject to energy efficiency testing consistent with the relevant requirements for that equipment. However, walk-in manufacturers typically make numerous envelope models and, even within a single model, the units are often customized in multiple ways. To reduce this potential burden, DOE proposes following the approach it has used for other equipment by allowing manufacturers to group equipment or models with essentially identical energy consumption characteristics into a single family of models, called a basic model. This concept has been established both for residential appliances and commercial and industrial equipment covered under EPCA. (See Title 10 of the Code of Federal Regulations (10 CFR) 430.2, which covers 26 products, and 10 CFR 431.12, 431.62, 431.132, 431.172, 431.192, 431.202, 431.222, 431.262, and 431.292, which cover various equipment.)

Walk-in refrigeration systems are often manufactured according to the same basic blueprint design, and any particular model could incorporate modifications that do not significantly affect the energy efficiency of the system. For example, manufacturers often sell systems that are designed to operate at different voltages. This allows them to market to customers with different electrical capabilities. The operating voltage affects the energy efficiency of the system, but very minimally. If manufacturers were required to test the efficiency of each model with a different feature, the testing burden would be significant, but yield effectively redundant results. Therefore, DOE provides for testing of a basic model of refrigeration systems that may not be identical, but would not have any electrical, physical, or functional characteristics that significantly affect energy consumption. Features that may affect the energy consumption of walk-in cooler and freezer refrigeration systems include compressor size, fan motor type, and heat exchanger coil dimensions.

Walk-in envelopes are often manufactured according to the same basic design, but the equipment is so highly customized that each walk-in a manufacturer builds may be unique, and potentially subject to testing as a separate basic model. For instance, changing the size of the envelope would affect the energy consumption obtained by the test procedure, even if the construction methods and materials were the same. To address this possibility, DOE proposes (1) grouping walk-in envelopes with essentially identical construction methods, materials, and components into a single basic model, and (2) adopting a calculation methodology for determining the energy consumption of units within the basic model. This methodology would require a manufacturer to test one unit of the basic model and then calculate daily energy consumption coefficients (DECCs) for that basic model according to the test procedure. The manufacturer could then apply those DECCs to other units within a basic model even if those units were not identical, to obtain the energy consumption of those units. Although units within a basic model need not share identical dimensions, finishes, and non-energy-related features (*e.g.*, shelving or door kick plates), they must have been manufactured using substantially the same construction methods, materials, and components. A few examples of factors that would necessitate a different basic model include changing the type of insulating foam, the method of locking together the panels of the walk-in envelope, or the electrical characteristics of the lighting. Examples of factors that may not constitute a different basic model include the type of exterior metal finish, the dimensions of the envelope, and the number of doors of the same type. The exterior metal finish would not have a substantial impact on the efficiency of the envelope. Dimensions and number of doors, on the other hand, would be accounted for in the energy consumption calculation using the DECCs from the unit of the basic model that was tested. (See section III.B.3.f for further discussion of DECCs.)

All of the equipment included in a basic model must be within the same equipment class. Components of similar design may be substituted in a basic model without requiring additional testing if the represented energy consumption measurements continue to satisfy the provisions for sampling and testing. Only representative samples within each basic model would be tested.

For walk-ins, DOE is considering adopting the following definition of ''basic model:'' ''Basic Model means all units of a given type of walk-in equipment manufactured by a single manufacturer, and—(1) With respect to envelopes, which do not have any differing construction methods, materials, components, or other characteristics that significantly affect the energy consumption characteristics. (2) With respect to refrigeration systems, which have the same primary energy source and which do not have any differing electrical, physical, or functional characteristics that significantly affect energy consumption.'' DOE requests comment on its proposed basic model approach.

2. Approach Option 1: Test the Unit as a Whole

In the framework document, DOE considered developing a test procedure for walk-ins by adapting an existing test procedure for commercial refrigeration equipment, such as ARI 1200–2006. This approach would require an entire walk-in cooler or freezer to be physically tested within a controlled test chamber in order to evaluate its energy consumption over a period of time. During the standards framework public meeting, DOE requested comments on the feasibility of this approach. Interested parties responded with significant reservations about using a modified version of the ARI 1200–2006 test procedure, citing crucial differences between walk-ins and commercial refrigeration equipment.

In particular, interested parties noted that walk-ins are physically different from commercial refrigerators in ways that make a full-system test burdensome or impractical. Manitowoc stated that for very large walk-ins, around the 3,000-square-foot limit in the EPCA definition, manufacturers might not have a large enough test facility to make the measurements necessary for the ARI 1200–2006 test procedure in a controlled environment. (Manitowoc, Public Meeting Transcript, No. 15 at p. 59) (In this and subsequent citations, ''Public Meeting Transcript'' refers to the transcript of the February 4, 2009, public meeting on standards for walk-in coolers and freezers. ''No. 15'' refers to the document number of the transcript in the Docket for the DOE rulemaking on standards for walk-in coolers and freezers, Docket No. EERE–2008–BT–TP–0014; and the page references refer to the place in the transcript where the statement preceding appears.) Kason Industries also stated that it would be practically impossible to have a large enough controlled climate enclosure to test medium to large walk-ins, and added that if a walk-in were a free-standing structure, testing it as a whole building would not be practical. (Kason, No. 16 at pp. 1, 4) (In this and subsequent citations, the document number refers to the number of the comment in the Docket for the DOE rulemaking on standards for walk-in coolers and freezers, Docket No. EERE–2008–BT–TP–0014; and the page references refer to the place in the document where the statement preceding appears.) The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) stated that the proposed test procedures were not practical because it would be costly to physically test walk-ins. (AHRI, No. 33 at p. 2)

Commenters also noted that the market for walk-in coolers and freezers is structured differently from the market for commercial refrigeration equipment, making a direct comparison between these types of equipment difficult. Manitowoc stated that the envelope of a particular unit of walk-in equipment may be manufactured by one company and the refrigeration system by another company. ARI 1200–2006 would require the two systems to be integrated before running the test, which would place the burden on the installer or someone beyond the manufacturer of the subsystems. (Manitowoc, Public Meeting Transcript, No. 15 at p. 59) AHRI agreed that the ARI 1200–2006 standard might not be the right approach and that DOE would need to separate the mechanical system from the envelope. (AHRI, Public Meeting Transcript, No. 15 at p. 62)

In addition to these concerns, commenters identified a deficiency in the ARI 1200–2006 test procedure. SCE stated that the majority of potential energy savings can be achieved using floating head pressure and variable-speed evaporator fans, both of which have varying effects depending on the time of day and the regional climate because the savings associated with each feature can depend on the ambient temperature and usage patterns of the walk-in over the course of a day. Because ARI 1200–2006 is a steady-state test, it would not capture the energy savings from either option. (SCE, Public Meeting Transcript, No. 15 at p. 63) AHRI agreed that the test procedure should capture savings from a control strategy or variable-speed components, both of which could optimize the operation of the walk-in for a variety of ambient conditions and usage patterns. An example of optimization would be allowing elements of the refrigeration system to turn off or reduce their operation at night when the walk-in is not being accessed. (AHRI, No. 33 at p. 2)

After considering these comments, DOE believes that an adapted version of ARI 1200–2006 would be inadequate to use as the test procedure for walk-in equipment. ARI 1200–2006 contains too many limitations and practical difficulties that would make it very difficult to effectively implement as a workable test procedure for walk-in. Therefore, DOE is no longer considering this approach.

3. Approach Option 2: Allow Manufacturers To Use Alternative Energy Determination Methods (AEDMs)

DOE's framework document also presented an alternative that would permit the use of an AEDM when determining walk-in energy consumption to help relieve the testing burden on manufacturers. An AEDM is a predictive mathematical model, developed from engineering analyses of design data and substantiated by actual test data which represents the energy consumption characteristics of one or more basic models. After confirming the accuracy of an AEDM, the manufacturer would apply the AEDM to basic models to determine their energy consumption without conducting any physical testing.

Applying this approach, the manufacturer would confirm the accuracy of the AEDM using the following method. First, the manufacturer would determine through actual testing the energy consumption of a certain number of its basic models that would be selected in accordance with criteria specified in the procedure. Second, the manufacturer would apply the AEDM to these same basic models. The AEDM would be considered sufficiently accurate only if: (1) The predicted total energy consumption of each of these basic models, calculated by applying the AEDM, is within a certain percentage of the total energy consumption determined from the testing of that basic model; and (2) the average of the predicted total energy consumption for the tested basic models, calculated by applying the AEDM, is within a certain percent of the average of the total energy consumption determined from testing these basic models. Under this approach, once the manufacturer verifies the accuracy of the AEDM, the manufacturer can use the AEDM to determine the energy consumption of other basic models without having to test those models. DOE requested comments on this approach during the framework public meeting, both in terms of how to implement the approach and whether such an approach was valid for walk-ins at all. DOE received several relevant comments, which are described and addressed below.

Given the unprecedented nature of using an AEDM to rate this type of equipment, DOE needed to determine both an appropriate sample size for verifying an AEDM and an acceptable minimum accuracy percentage for an AEDM. During the framework public meeting, DOE requested comments on these two values. AHRI could not provide feedback on how accurate the AEDM should be because DOE had not yet determined the test metric to apply. (AHRI, Public Meeting Transcript, No. 15 at p. 69) Manitowoc agreed that the test methodology needs to be established and experiments conducted to collect data that would be used to validate AEDMs. (Manitowoc, Public Meeting Transcript, No. 15 at p. 70) In a written comment, Kason Industries stated that an AEDM with a minimum accuracy of 66 percent would encompass a majority of the wide range of walk-in cooler and freezer applications. (Kason, No. 16 at p. 2) No commenter provided substantive data that DOE would use in its analysis to help support a particular sample size. Accordingly, DOE did not receive enough data from stakeholders that could help it determine an appropriate sample size or accuracy range to substantiate an AEDM.

During the public meeting, DOE also requested comments on the possibility of allowing manufacturers to take this approach to rate their walk-ins. Kason stated that an AEDM procedure would be preferable to using a physical test because the majority of walk-ins are custom-made by size, ambient temperature, and refrigeration demands. Therefore, it would be very difficult to create a test procedure that encompasses the range of walk-in equipment. (Kason, No. 16 at p. 1) Kason suggested that, as an alternative to testing the system as a whole, an AEDM could be based on determining efficiencies and performance characteristics for the principal components of a walk-in considering three factors: insulation and air tightness of the external envelope and door, efficiency of the refrigeration system for steady-state storage load (similar to the efficiency rating system for HVAC), and performance of the refrigeration system for removal of process heat and equipment-generated heat. (Kason, No. 16 at p. 2)

Other interested parties commented that allowing manufacturers to develop their own calculation methodology or software program as an AEDM could be problematic. Owens Corning questioned whether there could be a comparison among ratings published by manufacturers that developed different AEDMs. (Owens Corning, Public Meeting Transcript, No. 15 at p. 64) Craig stated that manufacturers who devise their own test procedures could write them in a way that benefits their own company. (Craig, Public Meeting Transcript, No. 15 at pp. 68–69) SCE stated that allowing manufacturers to develop their own software as an AEDM could be unfair to manufacturers with fewer resources, because the software is expensive and time-consuming to develop. Instead, SCE suggested that it would be better to have a transparent analysis method with the algorithms available to all participants and the data in a standardized format. (SCE, Public Meeting Transcript, No. 15 at p. 71) Craig replied that many manufacturers have sizing programs, which may be proprietary, to calculate the total load of the walk-in, accessories, and product load, and to size the refrigeration system properly for the energy requirements of the envelope. (Craig, Public Meeting Transcript, No. 15 at pp. 77–78 and No. 22 at p. 4) However, Craig stressed that requiring manufacturers to follow the same model developed or approved by DOE, would be fair to different manufacturers and provide consistent information to end users. (Craig, Public Meeting Transcript, No. 15 at p. 94 and No. 22 at p. 5)

ACEEE asserted that it would be difficult for DOE to work with many proprietary models, some of which might be difficult to verify. (ACEEE, Public Meeting Transcript, No. 15 at p. 94) NEEA also said that if an AEDM were used, the software should be equally available to all manufacturers and code officials for the purpose of determining compliance. (NEEA, No. 18 at p. 3) Crown Tonka stated that a standard configuration and standard test should be developed to create a baseline for energy usage, with normalizing factors associated with configuration changes. (Crown Tonka, No. 23 at p. 1) Owens Corning reiterated that a single AEDM should be accepted to keep comparisons consistent. (Owens Corning, No. 31 at p. 2)

DOE had previously understood that manufacturers would develop their own AEDMs and would verify their accuracy by testing a small number of walk-in models. However, as discussed above, most interested parties indicated that allowing manufacturers to develop their own rating calculations or software could be problematic, despite the fact that the calculations and software would need to be verified. Therefore, DOE does not propose to allow manufacturers to develop their own AEDMs. Instead, DOE developed its own calculation methodology for manufacturers to use in rating similar, but not identical, units of walk-in equipment. For further discussion on this methodology, see section III.B.3.f.

4. Proposed Option and Recommendation: Separate Envelope and Refrigeration Tests

Both methods described above were predicated on the assumption that an entire walk-in unit is manufactured by a single entity, which could either test the walk-in as a whole according to ARI Standard 1200–2006, or calculate the overall efficiency using an AEDM. In fact, as DOE learned, most walk-ins have two main manufacturers: One who manufactures the envelope and one who manufactures the refrigeration system that cools the interior of the envelope. (Other manufacturers may be involved in producing secondary components —such as fan assemblies or lighting— that are then purchased by the main manufacturers and incorporated as part of the refrigeration system or envelope.) These two parts are manufactured separately, and are often assembled together in the field by a third-party contractor who may not have been responsible for the manufacture of either part, and who may not have testing or evaluation capabilities. Because of this situation, DOE developed, and is proposing, a different approach for testing walk-ins, as described below.

Specifically, DOE proposes separate test procedures for the envelope and the refrigeration system. The envelope manufacturer would be responsible for testing the envelope according to the envelope test procedure, and the refrigeration system manufacturer would be responsible for testing the refrigeration system according to the refrigeration system test procedure. Such an approach would be more likely to generate usable data in support of standards for both the envelope and the refrigeration system during the development of any energy conservation standards for walk-in coolers and freezers. The two test procedures are described in sections III.B and III.C, respectively.

There are several advantages to this approach. First, having separate test procedures would allow individual component manufacturers to test their components—the envelope and the refrigeration system. These component manufacturers would be more likely to have access to the resources, equipment, and personnel needed to conduct the tests. On the other hand, the ''manufacturer'' of an entire walk-in system (*i.e.,* envelope and refrigeration system combined), could be a third party: A contractor who assembles the walk-in from the separate components and/or installs it in the field. This third-party assembler may even be the end-user or owner of the equipment. If a walk-in is assembled in the field, testing of the entire assembled system may not be feasible due to lack of expertise and the need for additional testing equipment.

Second, this approach would result in a significantly reduced testing burden while ensuring compliance with any standard DOE may develop. There are many more assemblers and installers of walk-ins than there are component manufacturers. Because EPCA requires manufacturers to demonstrate compliance with energy conservation standards, interpreting the term ''manufacturer'' to include assemblers and installers, who may be contractors or end-users, to demonstrate compliance with a standard would impose the compliance burden on entities who, more likely than not, may not have participated in the design and manufacture (and therefore energy efficiency) of the component parts. Furthermore, this approach would create substantial difficulties for DOE to enforce any standards it promulgates for walk-in equipment. While DOE considered the possibility that including assemblers and installers as parties involved in the manufacture of this equipment could encourage these parties to take steps to ensure that compliant equipment is installed, at this time, DOE believes that the testing burdens are best met by the envelope and refrigeration system manufacturers for the reasons discussed above. Accordingly, under today's proposal, only envelope and refrigeration system manufacturers would need to demonstrate compliance with any proposed standard through the use of the test procedure. (DOE notes that possible remedial action for failing to satisfy these requirements include civil penalties and injunctive relief to prevent the continued sale and distribution of noncompliant equipment.) (42 U.S.C. 6303–6304)

DOE requests comment on this proposed approach and whether it is appropriate for walk-ins.

B. Envelope

As described earlier, the envelope consists of the insulated box in which the stored items reside. The following discussion describes in greater detail the test procedure DOE is proposing for the walk-in envelope. DOE also addresses issues raised by interested parties.

This procedure contains the proposed methodology for evaluating the performance characteristics of the insulation as well as methods for testing thermal energy gains related to air infiltration caused by use (door openings) and imperfections in wall interfaces or door gasketing material. Heat gain due to internal electrical components is an additional consideration.

The proposed procedure utilizes the data obtained to calculate a measure of energy use associated with the envelope. In other words, the test procedure calculates the effect of the envelope's characteristics and components on the energy consumption of the walk-in as a whole. This includes the energy consumption of electrical components present in the envelope (such as lights) and variation in the energy consumption of the refrigeration system due to heat loads introduced as a function of envelope performance, such as conduction of heat through the walls of the envelope. The effect on the refrigeration system is determined by calculating the energy consumption of a theoretical, or nominal, refrigeration system, were it to be paired with the tested envelope. Using the same nominal refrigeration system characteristics allows for direct comparison of the performance of walk-in envelopes across a range of sizes, product classes, and levels of feature implementation.

The test procedure obtains a metric of energy use associated with the envelope of a walk-in cooler or freezer, consistent with the statutory requirement (42 U.S.C. 6314(a)(9)(B)(i)). For purposes of this rulemaking, DOE interprets the term ''energy use'' to describe the sum of (a) the electrical energy consumption of envelope components and (b) the energy consumption of the walk-in refrigeration equipment that is contributed by the performance of the envelope.

1. Overview of the Test Procedure

In accordance with EPCA, DOE is developing test procedures to evaluate the energy use associated with the envelope of walk-in coolers and freezers. The walk-in envelope includes, but may not be limited to, walls, floor, ceiling, seals, windows, and/or doors comprised of single or composite materials designed to isolate the interior, refrigerated environment from the ambient, external environment. For the purposes of developing this test procedure and evaluating potential performance standards for walk-in equipment, DOE considers the envelope to also include lighting and other energy-consuming components of the walk-in that are not part of its refrigeration system (*e.g.,* motors for automatic doors, anti-sweat heaters, etc.). DOE is considering the following definition for ''envelope,'' which would be inserted into 10 CFR part 431:

(1) The portion of a walk-in cooler or walk-in freezer that isolates the interior, refrigerated environment from the ambient, external environment; and

(2) All energy-consuming components of the walk-in cooler or walk-in freezer that are not part of its refrigeration system.

DOE requests comments on this proposed definition.

DOE also evaluated several available industry test procedures to measure the energy performance of various components of the walk-in envelope, but was unable to find a test procedure that would evaluate the entire envelope system. Consequently, DOE developed its own methodology, including a prescriptive calculation procedure, which incorporates specific component tests and allows for an overall energy performance value of the envelope to be determined. The proposed test measurements and accompanying calculation procedures to ascertain the overall energy performance value are described in the following sections.

2. Test Methods

As discussed above, DOE was unable to find a single, existing comprehensive test procedure for evaluating walk-in cooler and freezer envelopes. However, DOE identified and evaluated many recognized industry standards that could be applied to the testing of certain components and characteristics of walk-in envelopes. DOE incorporated an insulation test and an air infiltration test, with some modifications, into the proposed test procedure. The evaluation process, the results of the evaluation, and details of the proposed test methods are described in the following sections.

a. Insulation

Insulation comprises a significant component of walk-in units. EPCA specifies that ASTM C518–04, ''Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus,'' must be used, along with specific foam temperatures for freezer or cooler applications specified in EPCA, to determine the R value of individual walk-in envelope insulation materials. (42 U.S.C. 6314(a)(9)(A)) Commenters identified two issues of significance for DOE to consider when developing a test procedure for insulation: aging and moisture absorption. DOE discusses these issues in the subsections that follow.

i. Aging of Foam Insulation

EPCA requires that the test procedure for walk-ins use an R value that shall be the 1/K factor multiplied by the thickness of the panel. (42 U.S.C. 6314(a)(9)(A)) The Act does not specify when the R value should be calculated, a key issue interested parties raised at the framework public meeting. Specifying when the R-value should be calculated is a critical consideration because several sources indicate that the R-value of certain materials can change over time.

Craig stated that R values tend to deteriorate over time and that different materials exhibit unique rates of deterioration. (Craig, Public Meeting Transcript, No. 15 at p. 215 and No. 8 at p. 1) Craig expressed concern that using an initial R value (R value as measured within two weeks of manufacture) to determine compliance would ignore deterioration that occurs in blown foams over time. Craig argued that underestimating the energy use of walk-ins would be the likely outcome of using initial R-value, that it would be misleading for end-users, and that it would be inconsistent with the goals of the EISA 2007 legislation and the rulemaking process. (Craig, Public Meeting Transcript, No.15 at p. 215) A comment submitted jointly by representatives of ASAP, ACEEE, and NRDC (hereafter referred to as the ''Joint Comment'') stated that the test procedures used should account for the potential degradation of panel insulation and door seals over time. (Joint Comment, No. 21 at p. 2) Craig also recommended that DOE develop an accelerated test procedure that represents lifetime energy use and can be completed within 6 months. (Craig, No. 8 at p. 1)

In the context of foam insulation for walk-ins and the building industry, long-term thermal resistance (LTTR), described in greater detail below, refers to the impact of diffusion on the thermal resistance of insulation materials. In other words, the concentration of gaseous blowing agents contained in the foam, and which provide the foam with much of its insulating value, is reduced by both the diffusion of air into the foam and the secondary process of the blowing agent diffusing out of the foam. Because air has a significantly lower insulating value, the increased ratio of air to blowing agent reduces the foam insulation performance (this process is also known as ''aging''). This diffusion process causes foam to lose insulating value, which is represented by its R-value. As a concept, LTTR represents the R-value of foam material over its lifetime by describing insulating performance changes due to diffusion over time.

DOE investigated the issue of aging in foam insulation and found that it is widely accepted that the material properties of foam insulation made with gaseous blowing agents, other than air and including HFC–134a, HFC–245fa, HFC–365mfc, cyclopentanes, change over time. The amount of degradation can range from roughly 10–35 percent within 2 years of manufacture. Because use of ASTM C518–04 reflects the properties of a material at the time it is tested, using ASTM C518–04 to measure the insulating performance of a foam material at the time of manufacture would yield a result that differs from that produced by the same test conducted at some later point in time. Additionally, research has found that the vast majority of diffusion into and out of foam materials manufactured with blowing agents other than air occurs within the first 5 years of manufacture. Because the rate of diffusion follows an exponential curve, the majority occurs within the first year, after which the diffusion curve changes very little as it asymptotically approaches the equilibrium point.

DOE found that various methods of ''conditioning'' foam prior to measuring its insulating ability with American Society for Testing and Materials (ASTM) C518 have been developed in order to test aged insulating value, or LTTR. These standards are contained in five foam material specifications:

(1) ASTM C578–09, ''Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation;''

(2) ASTM C591–08a, ''Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation;''

(3) ASTM C1029–08, ''Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation;''

(4) ASTM C1126–04, ''Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation;'' and

(5) ASTM C1289–08, ''Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.''

DOE found that since their development in the 1980s, the most widely accepted conditioning methods are the 180-day conditioning at 73 °F or a 90-day conditioning at 140 °F. The goal of the 90-day conditioning method was to achieve the same aging result as the 180-day method in a shorter period of time. 180-day conditioning is used by ASTM C591–08a and ASTM C578–09 and the 90-day condition is typically used for ASTM C1089–08 and ASTM C1126–04. By accelerating the conditioning, the 90-day test sought to reduce the time and cost burdens for manufacturers. Although elevating the temperature of foams did achieve a faster rate of aging, subsequent research found that the results were not reliable indicators of actual aging because the relationship between the diffusion coefficient (a proportionality constant that describes the force or rate of diffusion for a given substance) and temperature are different for each gas. (Therese Stovall, ''Measuring the Impact of Experimental Parameters upon the Estimated Thermal Conductivity of Closed-Cell Foam Insulation Subjected to an Accelerated Aging Protocol: Two-Year Results,'' p. 1)

DOE found that efforts to develop an accelerated aging method that did not use elevated temperatures resulted in the creation of ASTM C1303, which in 1995 introduced the slicing and scaling method, also known as the ''thin slicing'' method (a technique used to slice the foam so that it ages more rapidly as a function of reduced thickness). In contrast to ASTM C578–09, ASTM C591–08a, ASTM C1029–08, ASTM C1126–04, and ASTM C1289–08, which specify the use of either the 180-day conditioning method or 90-day accelerate conditioning method to age the foam before measuring its thermal resistance. In contrast, the thin slicing method used in ASTM C1303–08 (the most recent version of ASTM C1303) was designed specifically to test the aging of foam insulation in duration shorter than 180 days, and without the temperature elevation methodology used in the 90-day test. (ASTM C1303–08, section 5.3, at p. 3) By reducing the length of the pathway for diffusion to take place, the ''aging'' can be accelerated without the confounding effects caused by unique gas properties of the material and blowing agent. The results are used to determine the R-value of foam 5 years after manufacture, a value that has been shown to correlate strongly with the average R-value of foam 15 years after manufacture. (ASTM C1303–08, section 5.4, at p. 3)

In early 2000, the National Research Council Canada and Institute for Research in Construction (NRC–IRC) developed CAN/ULC–S770–00. CAN/ULC–S770–00 incorporated elements of ASTM C1303–95 (the first version of ASTM C1303) but altered that standard by clarifying the slicing procedure used in ASTM C1303–95, as differing interpretations of the previous procedure were thought to be causing variations in the test results among third-party testing facilities. These changes sought to eliminate inconsistency in the interpretation of the slicing procedure and test setup to ensure uniformity across testing labs. In December 2000, CAN/ULC–S770–00 became the Canadian national mandatory test for calculating the LTTR of all foam insulation products (this test has since been updated; the most recent version is CAN/ULC–S770–03). Members of the U.S.-based Polyisocyanurate Insulation Manufacturers Association (PIMA) began to test their products using the same procedure on January 1, 2003. The LTTR calculated from this test procedure is used for all building insulation product labeling in Canada and PIMA products in the United States. Also in 2000, ASTM C1303–95 was updated as ASTM C1303–00.

In a 2005 rule by the U.S. Federal Trade Commission (FTC) in which the FTC considered requiring ASTM C1303–00 (the most recent version at that time) for product labeling on all foam insulation products, the FTC's review process revealed several unresolved issues related to the test procedure. (70 FR 31258 (May 31, 2005); 16 CFR Part 460, Labeling and Advertising of Home Insulation: Trade Regulation Rule, Final Rule) Subsequently, ASTM C1303–00 was updated to address these issues, which included foam stack composition, minimum slice thickness and slice source, the time between manufacture and test initiation, preparation of foam-in-place samples, and other clarifications of the procedure. This updated version was published as ASTM C1303–08 and is the most recent version of the standard to date.

Some commenters noted during the framework meeting that the application of an impermeable vapor barrier to the surface of the foam could reduce the impact of aging. Depending on its end use, foam insulation may have facers or skins applied to act as a vapor barrier and/or to enhance the bond of construction glues. Kysor stated that proper use of skins eliminates aging and the associated reduction of R-value in polyurethane panels. (Kysor (attachment), No. 29 at p. 1)

DOE examined this issue and found that foams used in walk-in panels are sometimes protected by impermeable barriers designed to prevent vapor and/or air exchange into or out of the foam or the interior of the walk-in. DOE found research conducted by the National Resource Council Canada (NRCC) suggesting that impermeable facers do not eliminate aging but may delay the rate of aging and/or the final equilibrium of the aged state. (Mukhopadhyaya, P.; Bomberg, M.T.; Kumaran, M.K.; Drouin, M.; Lackey, J.; van Reenen, D.; Normandin, N., ''Long-Term Thermal Resistance of Polyisocyanurate Foam Insulation With Impermeable Facers''; Mukhopadhyaya, P.; Bomberg, M.T.; Kumaran, M.K.; Drouin, M.; Lackey, J.; van Reenen, D.; Normandin, N., ''Long-Term Thermal Resistance of Polyisocyanurate Foam Insulation With Gas Barrier''; Mukhopadhyaya, P.; Kumaran, M.K. ''Long-Term Thermal Resistance Of Closed-Cell Foam Insulation: Research Update From Canada.'') In one of the summary observations of ''Long-Term Thermal Resistance of Polyisocyanurate Foam Insulation With Gas Barrier,'' the NRCC noted, ''a considerable amount of aging occurred in thin slice specimens despite having untouched impermeable facers, as well as a glass plate at the bottom of the specimens and edges sealed completely with epoxy coating.''

Additionally, the relationship between the skin and the rate of aging in foam depends on preserving the integrity of both the skin surface and the bonding between the skin and insulation. Punctures, made to allow for the installation of light fixtures, doors, and shelving, undermine the integrity of the skin. Walk-in insulation panels and their skins also typically separate over time due to shrinkage of foam materials after manufacture. While most foam materials contract by less than 1 percent of their total volume, shrinkage at this level is enough to create significant air gaps. DOE found that current methods of conditioning foam materials do not account for impermeable facers.

Finally, like the conditioning standards that are currently in use, ASTM C1303–08 is not designed to test impermeably faced foams that may be used with walk-ins. Significant research has been underway by the NRCC but no known test procedure is currently available that accounts for the effect of impermeable barriers. DOE requests feedback on this issue, including the submission of test results on the impact of impermeable skins on long-term R-value. DOE specifically requests that interested parties submit or identify peer-reviewed, published data on this issue.

DOE also requests feedback on the use of ASTM C1303–08 with impermeably faced foams. DOE may recommend the use of a test procedure specifically designed for impermeably faced foam if one is developed.

As a result of this evaluation, DOE proposes requiring manufacturers to use ASTM C1303–08 to determine the LTTR of walk-in foam insulation for the purposes of calculating the energy consumption of walk-in equipment. DOE requests comments on this proposal.

DOE is also proposing and seeking comment on the following exceptions to ASTM C1303–08:

(1) Section 6.6.2 of C1303–08 suggests that two standards for measuring the thermal resistance may be used. DOE proposes to allow use only of ASTM C518–04 (in EPCA, an incorrect form of the date suffix was used, *e.g.,* ASTM C518–[20]04), as specified in EPCA. (42 U.S.C. 6314(a)(9)(A)(ii))

(2) In section 6.6.2.1, in reference to ASTM C518–04, the mean test temperature of the foam during R-value measurement would be −6.7 ± 2 °C (20 ± 4 °F) with a temperature difference of 22 ± 2 °C (40 ± 4 °F) for freezers and 12.8 ± 2 °C (55 ± 4 °F) with a temperature difference of 22 ± 2 °C (40 ± 4 °F) for coolers. This change replaces the standard mean temperature of 75 °F for ASTM C518–04 with the EPCA specified values.

(3) For the purposes of preparing samples with foam-in-place method, section A2 should be followed exactly except for the following modifications to accommodate foam-in-place methods that may be used during the manufacture of walk-in panels:

- (3.1) Instead of following A2.3, which specifies that the foam be sprayed onto a single sheet of wood, the sample shall be foamed into a fully closed box of internal dimension 60 cm x 60 cm by desired product thickness (2ft x 2ft x Desired thickness). The box shall be made of ¾ inch plywood and internal surfaces wrapped in 4 to 6 mil polyethylene film to prevent the foam from adhering to the box material.
- (3.2) Instead of following section A2.4, which specifies the spraying of foam layers onto a open sheet of plywood, the cavity shall be filled using the manufacturer's typical foam-in-place method through a standard injection port or other process typically used to foam the product being tested.
- (3.3) In section A2.6, which defines the single surface in contact with the board to be the ''surface,'' the definition of the foam's ''surface'' shall be the two surface regions in contact with the 60 x 60 cm sections of the box.
- (3.4) Section A2.8 shall not be followed because the prepared sample will not have any ''free rise'' component.

DOE proposes that manufacturers select foam test thicknesses based on design specifications and practice. If a foam's thickness as manufactured varies from the tested product thickness, DOE proposes that the R-value of that foam at its manufactured thickness may be interpolated using the results of ASTM C1303–08, provided that the manufactured thickness does not vary from the tested product thickness by more than ± 0.5 inches. For example, if 4-inch and 6-inch products were prepared, interpolation between 3.5 and 4.5 inches would be allowed for the 4-inch foam and 5.5 and 6.5 inches for the 6-inch foam. If the manufacturer determines that final foam thickness should be outside of the tested range, then additional testing would be necessary to fit the criterion for interpolation. Manufacturers should make their sample selections accordingly to avoid the need for additional testing. DOE requests feedback on the use of interpolation within the specified ± 0.5 inch range.

DOE proposes that the results for each of the sample sets of three stacks should be reported as specified by ASTM C1303–08. As defined by ASTM C1303–08, after thin slices of foam are cut, the slices are organized into ''stacks'' of slices to match the original overall thickness of the sample. The procedure defines three stack types: (1) Stacks comprised of only surface slices of foam, (2) stacks of only core slices and (3) a mixture of core and surface slices. A ''surface'' slice and a ''core'' slice are defined in ASTM C1303 as ''a thin-slice foam specimen that was originally adjacent to the surface of the full-thickness product and that includes any facing that was adhered to the surface of the original full-thickness product'' and ''a thin-slice foam specimen that was taken at least 5 mm (0.2 in.) or 25% of the product thickness, whichever is greater, away from the surface of the full thickness product,'' respectively. The R-value of only the mixed stack would be used to calculate the energy performance of walk-ins. DOE requests feedback on this approach. ASTM is currently conducting a 5-year ''ruggedness'' test. Upon completion of the test, DOE may consider a rulemaking to modify the required number of stacks and/or which stack is best suited for labeling and calculating energy performance. DOE requests feedback on the use of the mixed stack R-value for the purpose of calculating walk-in energy use.

Additionally, DOE notes that ASTM C1303–08 is specifically intended for measuring the LTTR of foam materials. In light of this situation, the process contained in this standard would not apply to advanced insulation technologies such as vacuum insulated panels (VIPs) or aerogels. However, ASTM C518–04 can be used to measure the thermal properties of these new technologies, which, as specified in EPCA, is the required test for measuring insulating performance. (42 U.S.C. 6314(a)(9)(A)(ii)) DOE requests feedback on whether non-foam advanced technologies, such as VIPs or aerogels, would be likely to be used for walk-ins in the next 5 years. If DOE determines that these materials may be used in walk-ins in the next 5 years, DOE may consider alternative test procedures for capturing the long-term insulating value of any non-foam materials.

ii. Water Absorption in Foam

At the framework public meeting, interested parties raised the issue of R-value deterioration in foams due to moisture absorption. Craig stated that moisture penetration causes a decline in the R-value of foam insulation, at a rate that depends on the type of foam used. (Craig, No. 22 at p. 3) As is the case with aging, insulating foams exhibit different characteristics in the presence of moisture. Polystyrene foam is highly resistant to water absorption, whereas polyurethanes and polyisocyanurates are more easily damaged by exposure to moisture. In general, the solution to moisture issues involves creating an impermeable barrier between the insulation and the moisture source. However, Owens Corning asserted that customers routinely puncture metal skins to allow for the installation of lighting fixtures, shelving, and doors, creating holes that allow moisture to enter the insulation. (Owens Corning, Public Meeting Transcript, No. 15 at p. 61)

Although vapor permeance and water absorption tests exist, they are designed for measuring specific material properties rather than measuring system performance of composite structures like walk-ins. For a variety of reasons, these tests would be complex, costly, and time consuming to use because several sub-methods would need to be developed to quantify the impact of water on walk-ins. For every unique construction method and/or combination of materials (*e.g.,* blowing agent, foam type, barriers, gasketing materials, panel joint type, and method), the following considerations exemplify the challenges inherent in accounting for and quantifying insulating performance: (1) The rate at which the walk-in envelope collects water over its life must be measured or predicted using an accelerated test; (2) a saturation level or maximum absorption, if any, must be determined; and (3) a correlation between water absorption levels and insulation performance must be quantified. At this time, test procedures for each of these considerations are not yet recognized by a nationally recognized organization such as ASTM.

DOE reviewed several methods for testing vapor permeance and water absorption in foam insulation materials including ASTM E96, ''Standard Test Methods for Water Vapor Transmission of Materials,'' ASTM C209, ''Standard Test Methods for Cellulosic Fiber Insulation Board,'' ASTM C272–01 (2007), ''Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions,'' and ASTM D2842–06, ''Standard Test Method for Water Absorption of Rigid Cellular Plastics.'' Each of these standards describes a method for submerging a sample in water for a specified amount of time and then measuring the amount of water absorbed on a volume or weight basis. However, each one specifies significantly different immersion durations (ranging from 2 to 96 hours) and methods of weighing samples (blotting surfaces before measurement or using a buoyancy measurement). DOE believes that using the longest test period, 96 hours, would likely result in near worst case or maximum water absorption, but it is unclear how this directly translates to reduction in insulation performance for various materials.

Additionally, ASTM E96–05 measures vapor permeance under low vapor pressure gradient conditions. However, the temperature differentials in which walk-ins operate cause a high vapor pressure gradient, which has the effect of continuously driving moisture through the envelope. Neither ASTM E96–05 nor any other known procedures currently provide a methodology to accurately calculate the vapor permeance in walk-ins at the pressure gradients typically experienced in the field.

Some research has been completed, including a major study by the Cold Regions Research and Engineering Lab (CRREL). The CRREL study developed and applied a method for creating a vapor pressure gradient across various materials to quantify the rate at which these materials absorb and retain water over time. The insulating performance of the materials was also tested at various levels of moisture content to develop equations for the purpose of calculating the insulating properties at any moisture percentage relative to its dry weight. No other testing body has applied CRREL's testing procedures to replicate the results and most of CRREL's research was completed nearly 20 years ago. One of DOE's national labs has also begun development of procedures to evaluate the impact of moisture on insulation R-values, but this activity remains incomplete.

Given the discussion above, DOE does not propose to include the impact of water absorption on R-value in the test procedure because no well-accepted method has been developed. However, DOE will evaluate such a procedure if it is developed in the future.

b. Air Infiltration

Another major pathway for energy loss in walk-ins is air infiltration, or air exchanged into and out of a walk-in while all access points are closed or during door-opening cycles (*i.e.,* the openings of doors for the removal or stocking of product, or passage of customers, personnel, and/or machinery, also referred to as ''door-opening events''). Compared with other energy consumption factors such as conduction losses through insulation, air infiltration may be the largest contributing factor to envelope energy losses. Air infiltration can occur through steady-state leakage or from door opening events. As a result, designs and technologies that reduce infiltration during steady-state operation and door-opening events should be considered to reduce these losses.

EPCA includes prescriptive requirements for doors used on walk-ins, recognizing that a major portion of energy is lost through door opening cycles. All walk-in coolers or freezers ''manufactured on or after January 1, 2009, shall (A) have automatic door closers that firmly close all walk-in doors that have been closed to within 1 inch of full closure, except * * * doors wider than 3 feet 9 inches or taller than 7 feet; [and] (B) have strip doors, spring hinged doors, or other method of minimizing infiltration when doors are open * * *'' (42 U.S.C. 6313(f)(1)) During the framework public meeting, interested parties suggested methods for calculating infiltration from door-opening events within the test procedure.

These two infiltration pathways, steady-state leakage, and air losses due to door-opening events, are mitigated using distinct methods.

Steady-state infiltration (the air exchanged between the interior and exterior of a walk-in while all doors are closed, also referred to as ''leakage'') occurs because of the significant pressure gradient caused by the large temperature difference between the refrigerated space and the external environment. This pressure differential continuously induces air movement from the outside to the inside of a walk-in where leakage pathways exist. Leakage typically occurs through door frames, door gaskets, wall panel-to-panel interfaces, and wall-to-floor and wall-to-ceiling junctions. While considered minimal for small walk-ins, leakage becomes more significant as the walk-in size increases.

Air infiltration due to door openings is mostly a function of door area, opening frequency, duration, and air density. The primary means of reducing the amount of infiltration is by the use of active or passive infiltration reduction devices and devices that help reduce the time that doors are left accidentally ajar. Air curtains and strip curtains are good examples of active versus passive devices. The sections below describe the methods for testing the effectiveness of such devices and procedure for calculating air infiltration's impact on energy use in walk-ins.

Hired Hand recommended that the energy analysis for warehouse coolers and freezers include the performance of the door, including the number of door-opening cycles each day or week and factoring in optional door configurations such as automatic doors with or without strip curtains. (Hired Hand, No. 27 at p. 1) Eliason recommended that DOE consider average door cycling and door-ajar conditions in its test procedure. (Eliason, No. 19 at p. 1) Eliason noted that both of these conditions are part of the company's internal life-cycling test and represent real-world conditions. (Eliason, No. 19 at p. 1) Hired Hand stated that a simple rating for door infiltration performance could be based on door-opening cycles per week. (Hired Hand, No. 27 at p. 2) Hired Hand also suggested that DOE require consumer labeling to indicate the cost per minute of leaving the door open based on door size and application. (Hired Hand, No. 27 at p. 2)

Based on stakeholder comments and DOE review of the impact of air infiltration on energy use, DOE identified two methods that could be used to measure air infiltration in walk-ins: the blower door method and the gas tracer method. These methods are described in the following subsections.

i. Blower Door Method

DOE reviewed ASTM E1827–96 (2007), ''Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door,'' as a possible candidate test procedure for testing walk-ins. This method pressurizes or depressurizes the internal space using a large fan, typically placed in a doorway. The infiltration rate of the space can be directly calculated by measuring the pressure difference between the exterior and interior space and the air-flow rate through the fan.

After reviewing this test method, DOE identified reasons why the test might not be suitable for walk-ins. The blower door method is better suited for structures with relatively high rates of infiltration, such as buildings and homes, rather than the relatively low levels typically observed in walk-ins. In addition, known calibration curves for the blower door method require small temperature differentials (generally less than 10 °F) between the inside and outside of the envelope. However, walk-ins typically operate with a far greater differential that is normally greater than 40 °F. Another drawback to using this method with walk-ins is that the test setup procedure requires blocking a main entrance to the structure with the blower door. Because infiltration around the main door is a key source of infiltration in walk-ins and would not be measured as part of the test, this approach would not adequately capture the majority of the infiltration. For these reasons, DOE does not propose the use of the blower door method for measuring the air infiltration of walk-ins.

ii. Gas Tracer Method

DOE also reviewed ASTM E741–06, ''Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution.'' Although not as widely used as the blower door method, the gas tracer method has been used for decades by the building industry. The test is conducted by injecting a tracer gas, such as carbon dioxide or perfluorocarbons, into the internal space and measuring its concentration at recorded times. From these measurements, the average air change rate can be determined. While manual tools, such as syringes, or automated systems can be used to sample the air spaces, the test procedure lends itself to automation both for calibration and data collection. Depending on the gas and sampling method used, the gas concentration can be measured immediately with portable equipment. This method is also more accurate than the blower door method because it allows for direct measurement of infiltration without modification of the design conditions. (ASTM, ASTM E741–06 (2006), ''Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution,'' section 5.6, p. 3)

c. Steady-State Infiltration Test

For the reasons described above, DOE proposes using the gas tracer method described in ASTM–E741–06 for measuring the steady-state air infiltration of walk-ins, with the following six exceptions:

First, DOE proposes using the ''concentration decay method'' instead of other available options described in ASTM E741–06. DOE considers this method to be the simplest, fastest, most cost efficient, and most accurate.

Second, carbon dioxide (CO_2) is the recommended gas tracer for all testing because of the few human hazards related to its use, and the availability and relative cost of sampling equipment.

Third, the test would use the ''average air change rate'' method, in changes per hour (1/h), rather than the ''average air change flow'' method described in ASTM E741–06. The ''air change flow'' method allows for the direct measure of the exchange of air in cubic feet per hour and does not require measurement of the internal volume of the space but requires a more complex test setup and sampling method. In contrast, the ''air change rate'' method measures the rate of exchange of air per unit of time can be completed using relatively simple equipment. However, converting this value to a measurement of the flow, *e.g.,* volume of air exchanged per unit time, requires a precise measurement of internal volume. Since the precise internal volume of a given walk-in is readily available, DOE considers the ''air change rate'' method preferable to the ''air change flow'' method because the equipment is less expensive and the measurements are easier to obtain.

Fourth, ASTM E741–06 describes the importance of verifying proper gas mixing but does not describe where or how many spatial locations should be sampled. DOE proposes that spatial measurements shall be taken in a minimum of six locations or one location per 20 square feet (ft^2) of floor area (whichever results in a greater number of measurements), at a height of 3 ft ± 0.5 ft, or a minimum of 2 ft ± 0.5 ft from the inside wall of the walk-in envelope, to verify that the air space is uniformly mixed.

Fifth, DOE proposes the test be completed close to operational temperature to mimic the thermally induced pressure gradient seen in walk-ins. The internal air temperature shall be −23.3 (−10 °F) ± 2 °C (4 °F) for freezers and 1.7 (35 °F) ± 2 °C (4 °F) for coolers. The external air temperature should be 24 °C (75 °F) ± 2.5 °C (5 °F).

Sixth, the test should be completed with all doors closed. The resulting measurement shall be in units of changes per hour.

DOE requests feedback on its proposal to use ASTM E741–06 as the method for determining air infiltration and on the proposed exceptions to the test procedure.

For the purposes of administering the test, DOE considered the following options for the location of the test: (1) Require testing at a third-party testing facility. DOE believes that requiring that manufacturers to ship every walk-in manufactured, or a representative model, to a third-party facility for testing, would place a substantial burden on manufacturers; (2) require testing by a third party on site at a walk-in manufacturing facility. Completing the infiltration test at the manufacturing facility reduces logistical complexity and costs associated with testing. Since the equipment used to complete infiltration testing was originally designed for testing the performance of buildings, the equipment and protocols are designed to be mobile.

DOE believes that the most viable option is allowing testing to occur at the manufacturing facility, if preferred by the manufacturer. DOE requests feedback on the flexibility of location required for completion of any infiltration test.

iii. Door Infiltration Reduction Device Test

DOE is considering incorporating a door-opening test to quantify the impact of technologies such as strip curtains, air curtains, or other infiltration reduction devices during door-opening events. Due to the limited data available on these devices and the variety of technologies, DOE believes a standardized test would provide a more comprehensive and accurate picture regarding the effectiveness of these devices when compared to simply using effectiveness assumptions.

DOE proposes a two-part test to account for the effect of the door infiltration reduction device. First, measurements should be taken once the tracer gas has uniformly dispersed in the internal space using the methodology described in ASTM E741–06. Within 3 minutes ± 30 seconds, with the infiltration reduction device in place, a door should be opened at an angle of 90 degrees over a period no longer than 3 seconds, then held at 90 degrees in the open position for 5 minutes ± 5 seconds, then closed over a period no longer than 3 seconds. The gas concentration should be sampled again after the door has been closed. Samples should continue being taken until the gas concentration is once again uniformly mixed within the walk-in. Second, the test should be repeated exactly as described above with the infiltration reduction device removed or deactivated.

Using the measured infiltration with the device in place and without the device in place, the infiltration reduction effectiveness can be directly calculated:

$$E = \frac{V_{rate,with\text{-}device}}{V_{rate,without\text{-}device}} \times 100\% \qquad \text{Eq. 1}$$

Where:

$V_{rate,with\text{-}device}$ = air infiltration rate, with door open and reduction device active, using 4.2, 1/h;

$V_{rate,without\text{-}device}$ = air infiltration rate, with door open and reduction device disabled or removed, using 4.2, 1/h.

This calculation will yield a value between 0 and 100 percent, with 100 percent meaning that the device prevents all air infiltration when the door is open. DOE proposes using this calculated effectiveness for every unique door-device combination that a manufacturer may offer. DOE requests feedback on the proposed method for measuring the effectiveness of an infiltration reduction device.

iv. Infiltration Due to Door Openings

DOE does not propose to require manufacturers to measure the infiltration from all door-opening events. The complexity of testing, the variation of walk-in design, and various end-use behavior factors would make such a recommendation very difficult to execute. Instead, DOE proposes using analytical methods based on equations published in the ASHRAE Refrigeration Handbook in combination with assumed door-opening frequency, and duration of door cycles, to calculate the air infiltration associated with each door-opening event.

ASHRAE recommends using Gosney and Olama's (1975) air exchange equations for fully established flow through door openings (Equation 2). Several key assumptions have the greatest impact on predicated air exchange and are related to the calculation of the decimal portion or time a doorway is open, D_t. (ASHRAE, *Refrigeration Handbook*, 2006, section 13.5)

$$D_t = \frac{\lfloor (P \times \theta_p) + (60 \times \theta_o) \rfloor}{[3600 \times \theta_d]} \qquad \text{Eq. 2}$$

Where:

D_t = fractional door opening,

P = the number of doorway passages (or number of door-opening cycles for a given door),

θ_p = the door open-close time,

θ_o = the time the door stands open, and

θ_d = daily time period.

D_t is important for properly calculating the energy impact of air infiltration due to door-opening events. Therefore, the assumed values of P, θ_p, and θ_o will drive the result. The daily time period, θ_d, is simply assumed to be 24 hours.

For display glass doors, a P of 72 per day, θ_p of 8 seconds per passage, θ_o of 0 minutes and θ_d of 24 hours could be used. P of 72 per day is based on comments by Hired Hand and research on cold store infiltration. Hired Hand commented that the reach in frequency is approximately 400–600 per week (or one passage every 20 minutes assuming 18 hours per day per week). (Hired Hand, Public Meeting Transcript, No. 15 at p. 154) However, DOE identified a study by A.R. East, P.B. Jeffrey, and D.J. Cleland, ''Air Infiltration into Walk-in Cold Rooms,'' which suggested that this number should be closer to one passage every 10 minutes (assuming 18 hours per day per week). DOE suggests that the average of the two values of one passage every 15 minutes or P of 72 per day could be used. DOE chose the value of 8 seconds per passage but seeks comment on whether another value may be more appropriate.

For all other door or access types, a P of 60 per day, θ_p of 12 seconds per passage, θ_o of 15 minutes, and θ_d of 24 hours could be used. The number of passages reflects that other door types are typically accessed less frequently than glass doors. The value of 12 seconds per passage was selected based on the assumption that non-glass doors, such as those through which forklifts are driven in order to load product, will be open for longer periods of time than a typical display door. DOE selected the θ_o of 15 minutes due to the probability that a non-glass door will be propped open accidentally or intentionally. If an automatic door opener/closer is used for doors larger than 7 feet tall and 3 feet, 9 inches wide, then a θ_p of 10 seconds should be used.

DOE recognizes that with the variety of walk-in types and end-users, the frequency and duration of door-opening events is likely to vary significantly. As a result, DOE requests comments on the DOE assumed values for P, θ_p, and θ_o.

3. Calculations

In this section, DOE proposes a calculation methodology for using the results obtained from the measurements in the aforementioned tests, along with other known quantities, to calculate an energy use metric associated with the envelope. The steps in the proposed methodology are explained below.

a. Energy Efficiency Ratio

EPCA requires that the test procedure ''measure the energy use of walk-in coolers and walk-in freezers.'' (42 U.S.C. 6314(a)(9)(B)(i)) However, EPCA does not specify the units of measurement or units for reporting that are required. Based on a review of commonly used energy consumption metrics, DOE recommends the use of kWh/day as this unit is commonly recognized by end-users, manufacturers and other interested parties. However, a majority of metrics used to describe heat transfer losses are in units of British Thermal Units (BTU) per unit time. Therefore, to convert the British Thermal Units per hour (BTU/h) thermal energy transmission calculation into a measure of electrical energy consumed by the refrigeration equipment to remove the heat, DOE proposes using an energy efficiency ratio (EER) conversion based on a nominal efficiency of an assumed refrigeration system.

Because an envelope manufacturer cannot control where the refrigeration equipment is sited and the EER is intended to provide a means of comparison and not directly reflect a real walk-in installation, DOE proposes that the EER be 12.4 Btu per Watt hour (Btu/W-h) for coolers and 6.3 Btu/W-h for freezers. The difference in EER for coolers and freezers reflects the relative efficiency of the refrigeration equipment for the associated application. As the temperature of the air surrounding the evaporator coil drops (that is, when considering a freezer relative to a cooler), thermodynamics dictates that the system effectiveness at removing heat per unit of electrical input energy decreases. DOE requests feedback on the relative EERs of refrigeration equipment for a comparison basis.

b. Heat Gain Through the Envelope Due to Conduction

The energy calculation for all components that comprise the external surface area of the walk-in may be determined using the measured surface area, the measured foam R-value for the walls and ceiling, the R-value (or U-value) for glass doors, the design operation temperature, and the average ambient air temperature. Then, the associated heat transfer due to conduction can then be directly calculated.

i. Conduction Through Glass Display Doors

The heat conduction through the glass is one of the largest single contributors to energy consumption for walk-ins with a high ratio of glass surface area to non-glass surface. The thermal conductivity, the inverse of thermal resistivity or R-value, is commonly represented by the U-value in units of Btu/ft^2-°F-h. The thermal conductivity for most glass products, such as glass doors and windows used in buildings, is certified by a third party organization such as the National Fenestration Rating Council (NFRC). After certification, the product is granted a NFRC label and thermal conductivity performance rating. This rating represents an overall component performance including but not limited to the glass and the glass frame. However, in the case of glass products manufactured for the use in walk-ins, such as display doors, inset window and glass walls, DOE believes that glass component manufacturers currently do not participate in any third party rating programs nor do they provide products with performance labels. In addition, the performance data of these products is not readily available able in product literature.

In order for the thermal conductivity performance of glass products be incorporated into the walk-in test procedure, DOE proposes these two options: (1) If manufacturers of glass doors used in walk-ins participate in the same NFRC rating program, the performance of the door shall be simply read from its label and used for calculations in this test procedure. If glass door manufacturers do not participate in the same NFRC rating program, then (2) DOE would require manufacturers to use the free software package Window 5.2 (available here: *http://windows.lbl.gov/software/window/window.html*), that calculates the U-value, or thermal conductivity, of a glass door given precise specifications such as the size of the door, the number of panes of glass, the gas fill between the panes, etc. This tool was developed by Lawrence Berkeley National Lab (LBNL) and is known in the glass component industry to accurately predict glass door thermal performance from the given door characteristics. It has been used for many years and has been heavily verified by empirical test data. In order to ensure that inputs used to calculate overall door performance are not being manipulated by manufacturers, DOE intends to require the walk-in manufacturer to report the exact inputs and settings used in Window 5.2 to represent the door materials and glazing system. This will ensure transparency and accuracy by enabling other manufacturers and DOE to verify the integrity of the data and calculated performance.

DOE seeks comment on the availability of performance data on glass products used in walk-in applications, glass component manufacturers' participation in third party certification programs such as NFRC, and the proposed method for predicting the thermal performance of glass components using LBNL's Window 5.2 software package.

ii. Conduction Through Floors

In general, walk-in coolers are installed on top of concrete surfaces regardless of the walk-in type. For a walk-in cooler that does not have a floor supplied by the manufacturer, the average insulating performance of concrete will be assumed for the floor surface of the walk-in. Therefore, DOE proposes using an R-value of 0.6 ft^2-F-h/Btu for calculating the energy lost assuming the walk-in cooler are sited on 6-inch concrete floors of 150 lb/ft^3 density (ASHRAE Fundamentals Handbook). DOE requests feedback on the use of this R-value for coolers that are not shipped with an insulated floor.

Generally, walk-in manufacturers that sell large freezers do not install freezer floors. This task is normally subcontracted by the end-user before the walk-in is installed to ensure EPCA compliance. Therefore, DOE proposes using the minimum R-value specified in EPCA for walk-in freezer floors, R–28 ft^2-F-h/Btu, for energy performance calculations if the manufacture does not supply a floor to ensure EPCA compliance. (42 U.S.C. 6313(f)(1)(D)) DOE requests comments on the use of this proposed R-value for freezer floors.

c. Heat Gain Due to Infiltration

The amount of embodied energy in an air sample is primarily a function of its temperature and density or what is typically referred to as the enthalpy in a thermodynamic system such as a walk-in. The required amount of energy needed to remove heat from the air is calculated as the difference between the enthalpy of air entering the refrigerated space and enthalpy of the air inside the refrigerated space. This calculation is commonly used when designing walk-ins and typically uses dry-bulb and wet-bulb temperatures. The difference, per unit mass or volume of air, is calculated using the functional relationship between temperature and enthalpy. Using the measured infiltration rate from the required steady-state test described above or calculated analytical value for air infiltration for door-opening events and the calculated internal and external enthalpy, a rate of energy lost per hour (Btu/h) due to air exchange can be calculated.

d. Envelope Component Electrical Loads

Because the energy use of the walk-in refrigeration equipment is being analyzed separately from the envelope energy use, DOE is considering calculating the electricity consumption of lights, sensors, and other miscellaneous electrical devices using name-plate rating and assumptions about their daily operation, all of which would be incorporated into the evaluation of envelope energy use. In addition, because the test procedure for the refrigeration system will not include heating loads caused by lighting, heater wires, and other miscellaneous components, the thermal load from these components will be factored into the envelope calculations. DOE proposes as part of the test procedure calculations that 100 percent of the electrical energy consumed to operate the devices that are internal located in the walk-in, will be converted to thermal energy. This assumption is accurate since at steady-state, all the input electrical energy is converted completely into heat adhering to the physical laws of conservation of energy. While some electrical energy, which has been converted into light, may escape the controlled space via translucent glass display doors, this escaping energy is negligible. The associated thermal energy will then be used to calculate an additional compressor load that would be required to remove the additional heat generated by these components.

DOE recommends using the following equation to calculate the power usage for each electricity-consuming device type, P_{comp}, (kWh):

$$P_{comp,t} = P_{rated,t} \times (1 - PTO_t) \times n_t \times 24 \qquad \text{Eq. 3}$$

Where:

$P_{rated,t}$ = rated power of each component,
PTO_t = percent time off, and
n_t = the number of devices at the rated power.

DOE proposes that the rated power must be read from each electricity-consuming device product data sheet or name plate, and the n_t is the number of identical devices for which the P_{comp} calculation is being made.

DOE further proposes the use of the following equation to calculate additional compressor load due to heat generated by electrical components, C_{load}, (kWh):

$$C_{load} = P_{tot,int} \times \frac{3.412}{EER} \frac{Btu}{Wh} \qquad \text{Eq. 4}$$

Where:

EER = EER of walk-in (cooler = 12.4 or freezer = 6.3), Btu/W-h
$P_{tot,int}$ = The total electrical load due to components sited inside the walk-in envelope

The percent time off (PTO) value accounts for the reduction in energy use in walk-ins with component control systems installed and to specify the possible number of hours for various component types. While this value may not reflect behaviorally related energy consumption, such as how long an end-user typically leaves the lights on, it will provide a means for comparison of walk-in performance. To address the wide variety of devices that could be employed in a walk-in unit, DOE proposes the following PTO values:

(1) For lights, DOE proposes a PTO value of 25 percent for systems without timers or other auto shut-off systems and 50 percent for systems with timers or other auto shut-off systems installed.

(2) For anti-sweat heaters, DOE proposes a PTO value of 0 percent for all systems without direct or indirect relative humidity sensing controls. DOE further proposes that a PTO value of 75 percent be used for walk-in coolers, and 50 percent for walk-in freezers with these controls. (Focus on Energy, BP–3429–0304, ''Anti-Sweat Heater Controls,'' 2004, p. 1)

(3) For electrically powered devices (such as air curtains) that mitigate air infiltration but are not actively controlled based on door open or closed positions, DOE proposes a PTO value of 25 percent.

(4) For electrically powered devices that mitigate air infiltration that are also actively controlled based on door open or closed position for *display doors*, DOE proposes a PTO value of 99.33 percent.

(5) For electrically powered devices that mitigate air infiltration that are also actively controlled based on door open or closed position for *all other doors*, DOE proposes a PTO value of 99.17 percent.

(6) For all other devices, DOE proposes a PTO value of 0 percent, unless the walk-in manufacturer can demonstrate that the device is controllable by a preset control system. If this can be demonstrated, then DOE proposes a value of 25 percent for the device in question.

DOE seeks comments on these assumptions.

e. Normalization

A single metric would make comparing the energy use of walk-ins much more straightforward. DOE proposes using a calculation for energy consumption per unit time and a normalization factor to account for differences in glass and non-glass external surface area depending on the product class. During the framework public meeting and in written comments, some interested parties recommended that DOE use volume as the normalization factor for performance standards. (Manitowoc, Public Meeting Transcript, No. 15 at p. 56; EEI, Public Meeting Transcript, No. 15 at p. 116; NEEA, No. 18 at p. 3) Crown Tonka, in a written comment, recommended that the test metric be kWh per cubic foot (*i.e.*, energy consumption normalized by volume). (Crown Tonka, No. 23 at p. 1) The Joint Comment recommended that DOE use surface area as the normalization factor. (Joint Comment, No. 21 at p. 2) A comment submitted jointly by representatives of SCE, SMUD, and SDG&E (hereafter referred to as the Utilities Joint Comment) also stated that DOE should use surface area as a normalization factor. (Utilities Joint Comment, No. 32 at p. 7)

Many established metrics use a per-day time scale normalized by product volume. However, surface area is the key geometric characteristic related to both conduction and infiltration because volumetric normalization cannot directly account for the higher conduction and infiltration losses associated with glass doors and windows. Conduction and infiltration losses through glass become particularly important considerations as the ratio of glass door area to total wall area increases, as is the case in walk-ins designed for customer access. Using surface area as the normalization factor would account for these losses through any glass door or window used in a walk-in. Therefore, DOE proposes the use of surface area as a normalization factor for performance calculations of walk-ins. DOE requests comments on this proposed normalization method.

f. Daily Energy Consumption Coefficients

As discussed in section III.A.1, DOE proposes allowing manufacturers to group similar units together into a single ''basic model.'' This approach would reduce the testing burden as only one unit of each basic model would be subject to testing. However, in the case of envelopes, the equipment is so highly customized that each unit a manufacturer builds may be unique. For example, units may have identical materials, components, or construction methods, but may be built to varied dimensions, which could result in different energy consumption values being obtained using the proposed test methods.

In order to compare units that are similar enough to be included in the same basic model, but that are not identical, the test procedure allows for calculating daily energy consumption coefficients (or DECCs), using test results from a particular unit within a basic model, and then applying these DECCs to other units within a basic model to calculate the energy consumption of the other units. DECCs are essentially scaling factors that allow a manufacturer to change certain parameters of an envelope and calculate the corresponding change in energy consumption. In the case of today's proposed procedure, these parameters would be wall surface area, non-glass door surface area, glass display door surface area, glass wall and inset window surface area, infiltration due to opening of non-display type doors and infiltration reduction due to reduction devices in place on non-display doors, infiltration due to opening of display type doors and infiltration reduction due to reduction devices in place on display doors, and electrical energy consumption due to devices including, but not limited to, lights, anti-sweat heaters, and motors to drive air mixing fans. The expression for daily energy consumption is formulated on the assumptions that: (1) Energy consumption due to conduction losses scales linearly with surface area; (2) energy consumption due to infiltration scales linearly with the number of doors of each type and total wall surface area; (3) energy consumption of anti-sweat door heaters scales linearly with total door surface area; and (4) energy consumption of other electrical components including lighting and stirring fans scales linearly with the interior volume of the envelope.

Once the DECCs are calculated from a tested walk-in envelope, they are combined to provide a linear expression of the daily energy consumption of any walk-in envelope of the same basic model as the tested envelope (that is, having the same construction methods, materials, components, and other energy consumption characteristics as the tested envelope), as follows:

$$E_{tot,system} = DECC_{non\text{-}glass} \times A_{non\text{-}glass,tot} + DECC_{glass} \times A_{glass,tot} + DECC_{infilt,disp\_dr\_opn} \times A_{disp\_doors} + DECC_{disp\_dr\_device} \times n_{disp\_doors} + DECC_{infilt,non\text{-}display,dr\_opn} \times A_{non\text{-}display\text{-}doors} + DECC_{non\text{-}display\text{-}dr\_device} \times n_{non\text{-}display\text{-}doors} + DECC_{light} \times V_{ref\_space} + DECC_{ASH} \times A_{disp\_doors} + DECC_{stir\_fan} \times V_{ref\_space} + DECC_{other} \times V_{ref\_space} \quad \text{Eq. 5}$$

Where:

$DECC_{non\text{-}glass}$ = DECC for non-glass,
$A_{non\text{-}glass,tot}$ = total non-glass surface area,
$DECC_{glass,door}$ = DECC for glass doors,
$A_{glass,glass,\ tot}$ = total glass surface area, and
$DECC_{glass,wall}$ = DECC for glass walls and inset windows,
$A_{glass,wall,\ tot}$ = total glass wall and inset window surface area, and
$DECC_{infilt,disp\_dr\_opn}$ = DECC for opening of display type doors,
A_{disp_doors} = total area of display doors,
$DECC_{disp\_dr\_device}$ = DECC for infiltration reduction device in place for display doors,
n_{disp_doors} = total number of display doors,
$DECC_{infilt,non\text{-}display\_,dr\_opn}$ = DECC for non-display type doors,
$A_{non\text{-}display\_doors}$ = total area of non-display type doors,
$DECC_{non\text{-}display\_dr\_device}$ = DECC for infiltration reduction device in place for non-display doors,
$n_{non\text{-}display\_doors}$ = total number of non-display doors,
$DECC_{light}$ = DECC for lights,
V_{ref_space} = total enclosed refrigerated volume(ft^3),
$DECC_{ASH}$ = DECC for anti-sweat heaters,
$DECC_{stir\_fan}$ = DECC for motors used to drive air mixing fans, and
$DECC_{other}$ = DECC for other electricity consuming devices.

Only applicable DECCs shall be used. For example, if a certain basic model did not have glass display doors, DECCs and variables pertaining to glass display doors would not be calculated, nor would they be included in the equation of energy consumption.

DOE believes that this approach would reduce the testing burden on manufacturers because it would not require manufacturers to test every unit produced with slight variations due to customer specification. However, by specifying a calculation methodology that manufacturers must use, the approach reduces the potential for inconsistency among manufacturers' rating methods, a concern that interested parties raised about DOE's previous idea to allow each manufacturer to develop its own AEDM for rating similar, but not identical, equipment. (See section III.A.3 for discussion of comments about this issue.) DOE requests comment on the proposed approach of specifying a formula based on DECCs, and on the assumptions that DOE made in generating this formula. DOE also asks if there are other parameters it should consider when calculating DECCs.

C. Refrigeration System

As previously discussed, a differentiation was made for the purposes of this test procedure between the envelope or structure of the walk-in cooler or freezer and the mechanical refrigeration system performing the physical work necessary to cool the interior space. The refrigeration system in this context is further subdivided into three categories, consisting of single-package systems containing both the condensing and evaporator units, split systems with the condensing unit and unit cooler physically separated and connected via refrigerant piping, and rack systems utilizing unit coolers, which receive refrigerant from a shared loop. The proposed test procedure contains separate specific provisions for the standardized testing of each refrigeration system type. Later sections provide a general overview of the test procedure for refrigeration systems of walk-in coolers and freezers and address some of the technical issues pertinent to the proposed test procedure. The following section also addresses issues raised by interested parties.

1. Overview of the Test Procedure

In accordance with EPCA, DOE proposes to adopt a test procedure for measuring the energy consumption of the refrigeration system of walk-in coolers and freezers. (42 U.S.C. 6314(a)(9)(B)(i)) DOE is considering adding the following definition for ''refrigeration system'' to 10 CFR part 431, subpart R: ''Refrigeration system means the mechanism used to create the refrigerated environment in the interior of a walk-in cooler or freezer, consisting of an integrated single-package refrigeration unit, or a split system with separate unit cooler and condensing unit sections, or a unit cooler that is connected to a central rack system; and including all controls and other components integral to the operation of this mechanism.'' DOE requests comments on this proposed definition.

In the framework document, DOE examined in detail six test procedures developed either by AHRI or ASHRAE that relate to the measurement of energy consumption of refrigeration equipment to determine whether they could apply to walk-in refrigeration systems. Although the six procedures collectively covered all of the components of the refrigeration systems of walk-in coolers and freezers (*i.e.*, the compressor, the condenser, the condensing unit or the unit cooler), each of these existing procedures covered only one or some of the components, and none applied to the testing of the complete refrigeration system. The rating conditions specified in those procedures also are generally not representative of typical conditions found in walk-in equipment.

During the framework public meeting and in a written comment, AHRI informed DOE that it has begun developing a standard for the performance rating of walk-in cooler and freezer refrigeration systems. (AHRI, Public Meeting Transcript, No. 15 at p. 50; AHRI, No. 33 at p. 3) This standard, AHRI Standard 1250P, ''2009 Standard for Performance Rating of Walk in Coolers and Freezers,'' was published in September of 2009. DOE has reviewed the final, published version of AHRI Standard 1250P and proposes to incorporate it by reference into this test procedure.

The test procedure DOE proposes to adopt covers testing of refrigeration systems for walk-in coolers and freezers, including unit coolers and condensing units that are sold together as a matched system (*i.e.*, paired with each other in a way that optimizes the performance of the system), as well as unit coolers and condensing units sold separately, including unit coolers connected to compressor racks. The procedure describes the method for measuring the refrigeration capacity and the electrical energy consumption for the condensing unit and the unit cooler, as well as the off-cycle fan energy and the defrost subsystem under specified test conditions. The standard test conditions specify the dry-bulb and wet-bulb temperatures, the relative humidity for both the unit cooler and the condensing unit, and require that the system must operate under steady-state conditions. The test procedure groups walk-in cooler and freezer systems into four categories by distinguishing between indoor and outdoor locations for the condensing unit, and between coolers and freezers. The test procedure also specifies calculations for the nominal box loads for each of the four categories under typical low- and high-load conditions, expressed as a function of the ambient air temperature. (The ''nominal box load'' refers to the refrigeration load imposed on the system by the walk-in envelope. Similar to the way in which the envelope was assumed to be paired with a refrigeration system of a given EER to provide a means of comparison between different envelopes, DOE assumes that the refrigeration system is paired with an envelope of given heat transfer characteristics. This assumption is made for comparison purposes. See section III.B.3.a for further discussion of this concept.) For systems in which the condensing unit is located outdoors, the test procedure uses bin temperature data and bin hour data to represent the impact of the seasonal variation in outside ambient air temperature on energy use. The test procedure computes an annual walk-in efficiency factor, or AWEF, for the refrigeration system under a specified thermal load profile over a 24-hour operation period.

2. Test Conditions

DOE received several comments on test conditions. The Utilities Joint Comment stated that most of the potential energy savings can be achieved using floating head pressure and variable-speed evaporator fans, both of which are time-varying and weather dependent, and a steady-state test may not capture these savings adequately. (Utilities Joint Comment, No. 32 at p. 4) Manitowoc stated that energy usage can depend on the heat load in the box consisting of defrost energy and fan energy, both of which depend on the refrigeration system control strategy. (Manitowoc, Public Meeting Transcript, No. 15 at p. 76) NEEA stated that the test conditions should reflect variations in the location of the condensing unit, thermal load conditions, and outdoor air temperature. (NEEA, No. 18 at p. 3)

The test procedure DOE proposes specific conditions for both the interior and exterior of the walk-in to determine the net refrigeration capacity. The interior conditions of the unit cooler are specified as nominal temperature and humidity conditions: 2 °C dry-bulb and less than 50 percent relative humidity (RH) for coolers, and −23 °C dry-bulb and less than 50 percent RH for freezers. The proposed test procedure would measure both net refrigeration capacity and off-cycle fan power at those conditions for the unit cooler. For the condenser, the test procedure would specify three different ambient conditions for dry-bulb and wet-bulb temperatures: Hot (35 °C/24 °C), moderate (15 °C/12 °C) and cold (2 °C/1 °C). The purpose of specifying three sets of ambient conditions is to capture the variation in capacity under different ambient temperatures.

For two-capacity condensing units, the test procedure would measure the net refrigeration capacity under the same set of ambient conditions for the condenser at both the minimum and maximum capacity levels. Variable-speed condensing units would also have their refrigeration capacities measured at an additional intermediate capacity level. Because the test procedure provides for measurement of the compressor power and the fan power at two compressor capacity levels for two-speed systems and at three capacity levels for variable-speed systems at multiple outside ambient air temperature levels, DOE believes that the proposed test conditions reasonably reflect the energy savings that may be achieved through the control strategies referred to by interested parties. Also, as mentioned above, the proposed procedure includes a measurement of off-cycle fan power, which would account for energy savings due to variable-speed evaporator fans.

The Joint Comment stated that test procedures should account for partial-load conditions as well as maximum loading, and that test methods limited to maximum load conditions at steady-state operation are insufficient. (Joint Comment, No. 21 at p. 2) ACEEE also stated that the efficiency metric of the refrigeration system should reflect part-load conditions. (ACEEE, Public Meeting Transcript, No. 15 at p. 99) In the proposed test procedure, DOE has provided for testing of two-capacity and variable-capacity condensing units at the minimum capacity level, which would correspond to the appropriate low-load level condition for an appropriately sized unit. However, for a single-capacity unit, low-load conditions would lead to a higher frequency of equipment cycling because the equipment would be sized for a much larger load; that is, a load consistent with worst-case conditions. For single-speed equipment, the proposed test procedures do not capture the impact of this cyclic degradation. DOE believes that capturing the cyclic degradation is not necessary because, averaged over representative locations in the entire country, walk-in coolers may operate for many hours at the full-load condition. For instance, the daily pull-down-load in typical walk-in cooler and freezer installations is met over a period of 5 to 8 hours of full-load operation for a properly sized unit. Consequently, the impact of the cyclic degradation is not very significant for the walk-in cooler or freezer refrigeration system.

Craig noted that the refrigeration systems of walk-in equipment are often oversized to account for the worst weather conditions and additional pull-down load (Craig, Public Meeting Transcript, No. 15 at p. 97). Nor-Lake stated that its methodology for determining the refrigeration load for the walk-in takes into account the worst conditions over the typical annual cycle, as well as product load, pull-down load, the number of door openings, and duration (Nor-Lake, No. 30 at p. 2). The proposed test procedure computes the energy use on the basis of a nominal box load, which takes into account product load, infiltration load due to door openings, and transmission load through the box walls and roof. DOE believes that the values for the nominal box loads adequately reflect typical oversizing values. The proposed annual energy efficiency metric is based on weather conditions that are considered representative of the population-weighted average weather conditions of the country as a whole.

3. Test Methods

The net refrigeration capacity of the system is determined by one of the following test methods: (1) DX Dual Instrumentation measures the enthalpy change and the mass flow rate of the refrigerant across the unit cooler using two independent measuring systems; or (2) DX Calibrated Box measures the enthalpy change and the mass flow rate of the refrigerant across the unit cooler and the heat input to the calibrated box. In the first method, the test unit cooler and the matched condensing unit are kept inside separate environmental chambers. In the second method, the condensing unit is placed inside the environmental chamber, while the unit cooler is kept inside a calibrated box, which is inside a temperature-controlled enclosure.

DOE believes the test methods are appropriate for walk-ins because they were adapted from AHRI Standard 420–2008, ''Performance rating of forced-circulation free-delivery unit coolers for refrigeration,'' and ASHRAE Standard 23, ''Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units,'' and have been widely used in the refrigeration industry for many years. Furthermore, these test methods were developed and approved by the industry and published by the industry trade association as a sufficiently adequate means of assessing the net refrigeration capacity of equipment that share many functional similarities with walk-ins, such as components, materials, and substances (*e.g.,* the refrigerant) that provide the mechanical means of refrigeration. The test methods DOE is proposing today also account for ways in which walk-in refrigeration systems differ from commercial refrigeration equipment; as in their operating conditions, configurations, or patterns of use. For example, condensing units of walk-in refrigeration systems may be located outdoors and experience a wider range of operating temperatures than commercial refrigeration, which is generally located indoors; the walk-in refrigeration test procedure specifies three different ambient temperatures at which to test, in order to approximate actual conditions under which the system might operate. Furthermore, DOE's proposed methods improve upon previously developed refrigeration test methods by accounting for the energy-saving effects of advanced technologies such as variable-speed fans and defrost control strategies.

4. Measurements and Calculations

The test procedure DOE proposes to adopt, AHRI Standard 1250P–2009, measures certain parameters, including the net refrigeration capacity and the off-cycle fan power for both coolers and freezers. The defrost power and thermal energy transferred to the defrost drain water are measured for a defrost cycle for freezers only. Separate calculation procedures for single-capacity, two-capacity, and variable-capacity equipment are included in the test procedure. The test procedure determines the annual walk-in energy factor, or AWEF, as the ratio of the annual net heat removed from the box, which includes the internal heat gains from non-refrigeration components but excludes the heat gains from the refrigeration components in the box, to the annual electrical energy consumption. The final metric determined by this procedure is a measure of efficiency. However, DOE is required by EPCA to establish ''a test procedure to measure * * * energy use.'' (42 U.S.C. 6314(a)(9)(B)(i)) In light of this requirement, DOE proposes that manufacturers determine both the AWEF and the annual energy consumption of their equipment using the test procedure, which will enable the test procedure to be consistent with the requirements of EPCA to develop test procedures that measure the energy consumption of walk-in equipment.

In the AHRI Standard 1250P–2009 calculations, the annual net heat removed from the nominal box is represented as a function of ambient temperature surrounding the condenser and the measured net refrigeration capacity at the highest test temperature. For refrigeration systems consisting of a unit cooler and a dedicated condensing unit, the annual net heat removed from the box can be calculated from the system capacity and, for systems located outdoors, the net heat removed from the nominal box at a given bin temperature weighted by the number of hours corresponding to the bin temperature. The temperature bin data listed in Table D1 of AHRI Standard 1250P–2009 has been constructed from the ambient temperatures over a typical meteorological year for a specified location, corresponding closely to the use cycle parameters prescribed in other DOE standards. For refrigeration systems consisting of a unit cooler connected to a remote rack, the net heat removed is a function of the unit cooler capacity at the test points specified in AHRI Standard 1250P–2009.

DOE is considering deriving the expressions for the annual net heat removed from the box, that is, the numerator of the equations for energy consumption, by simplifying the equations in AHRI Standard 1250P–2009. As an example, the calculation methodology for indoor coolers using AHRI Standard 1250P–2009 would be as follows:

The AWEF, for walk-in cooler systems with dedicated condensing units located indoors, is determined by

$$\mathrm{AWEF} = \sum_{j=1}^{n} \left[\mathrm{BL}(t_j) / \mathrm{E}(t_j) \right], \qquad \text{Eq. 6}$$

Where $\Sigma[\mathrm{BL}(t_j)]$ is the annual net heat removed from the box over the course of the year, and $\Sigma[\mathrm{E}(t_j)]$ is the annual energy consumption of the system. Thus,

$$\sum_{j=1}^{n} \mathrm{E}(t_j) = \sum_{j=1}^{n} \mathrm{BL}(t_j) / \mathrm{AWEF}. \qquad \text{Eq. 7}$$

AWEF is calculated directly using the test procedure, while $\mathrm{BL}(t_j)$ is calculated by:

$$\mathrm{BL}(t_j) = \left[0.33 \times \mathrm{B\dot{L}H}(t_j) + 0.67 \times \mathrm{B\dot{L}L}(t_j) \right] \times n_j. \qquad \text{Eq. 8}$$

For indoor units, t_j is assumed to be constant; thus, n_j = 8760, the total number of hours in a year. BLH and BLL are given by, respectively,

$$\dot{BLH} = 0.7 \times \dot{q}_{ss}(90\ ^{\circ}F) \qquad \text{Eq. 9}$$

and

$$\dot{BLL} = 0.1 \times \dot{q}_{ss}(90\ ^{\circ}F), \qquad \text{Eq. 10}$$

Where $q_{ss}(90\ ^{\circ}F)$ is the system steady state refrigeration capacity at 90 °F. When terms are combined and the expression simplified, the equation for annual energy consumption becomes

$$\text{Annual Energy Consumption} = \frac{0.30 \times \dot{q}_{ss}(90\ ^{\circ}F) \times 8760}{AWEF}. \qquad \text{Eq. 11}$$

DOE requests comment on using these equations to derive annual energy consumption.

D. Compliance, Certification, and Enforcement

Finally, DOE addresses below compliance, certification, and enforcement issues involving walk-ins. At this time, DOE is not proposing any specific requirements for this equipment. As discussed below, DOE will consider addressing these issues in a separate rulemaking. Any data on which a manufacturer relies for the purposes of certifying compliance with any applicable standards that DOE promulgates for this equipment would be derived from the test procedure that DOE adopts. The adopted procedure would also be used by DOE during enforcement-related testing.

1. Provisions for Energy Conservation Standards Developed by the Department of Energy

The purpose of establishing compliance, certification, and enforcement regulations is to provide reasonable assurance that manufacturers appropriately test and accurately represent the performance characteristics of commercial equipment. DOE recently incorporated the standards prescribed by EISA 2007, including those for walk-ins, into 10 CFR parts 430 and 431. 74 FR 12074 (March 23, 2009). However, DOE has not yet proposed or issued amended energy conservation standards for walk-ins. DOE will consider issuing compliance, certification, and enforcement provisions for walk-ins in a future rulemaking. Therefore, today's notice proposes no certification, compliance, or enforcement provisions for energy conservation standards for walk-ins.

2. Provisions for Existing Design Standards Prescribed by Congress

DOE is responsible for enforcing Federal energy standards, whether those standards were developed through a DOE rulemaking pursuant to EPCA or prescribed by Congress. In EISA 2007, Congress prescribed design standards specifically for walk-ins that took effect on January 1, 2009. Typically, DOE establishes specific enforcement regulations for each product covered by existing standards, which may require manufacturers to file documents such as a compliance statement and a certification report. In a compliance statement, the manufacturer certifies its products meet the requirements. In a certification report, the manufacturer provides product-specific information that would enable DOE to determine whether the product meets the standard. DOE has already established compliance and certification requirements for other products.

Until DOE finalizes regulations that require compliance statements and certification reports for walk-ins, manufacturers will not be required to report data to DOE, but they must still meet all prescribed design standards that went into effect on January 1, 2009. If there is a question on compliance with design standards, the manufacturer must make a reasonable case that the equipment meets those standards.

To address concerns about the EISA 2007 design requirements for walk-ins, DOE maintains a Frequently Asked Questions page on the DOE Web site at *http://www1.eere.energy.gov/buildings/appliance_standards/commercial/wicf_faqs.html.*

IV. Regulatory Review

A. Review Under Executive Order 12866

The Office of Management and Budget has determined that test procedure rulemakings do not constitute ''significant regulatory actions'' under Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (October 4, 1993). Accordingly, this action was not subject to review under that Executive Order by the Office of Information and Regulatory Affairs (OIRA) of the Office of Management and Budget (OMB).

B. Review Under the National Environmental Policy Act

In this proposed rule, DOE proposes to adopt test procedures and related provisions for walk-in equipment. The test procedures would be used initially for the purpose of considering the adoption of energy conservation standards for walk-ins, and DOE would require their use only if standards were subsequently adopted. The proposed test procedures will not affect the quality or distribution of energy and, therefore, will not result in environmental impacts. Therefore, DOE determined that this rule falls into a class of actions that are categorically excluded from review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*) and the Department's implementing regulations at 10 CFR part 1021. More specifically, today's proposed rule is covered by the Categorical Exclusion in paragraph A6 to subpart D, 10 CFR part 1021. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

C. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking'' (67 FR 53461 (August 16, 2002)), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of General Counsel's Web site, *http://www.gc.doe.gov.*

DOE reviewed the test procedures considered in today's notice of proposed rulemaking under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. As discussed in more detail below, DOE found that because the proposed test procedures have not previously been required of manufacturers, all manufacturers, including small manufacturers, could potentially experience a financial burden associated with new testing requirements. While examining this issue, DOE determined that it could not certify that the proposed rule, if promulgated, would not have a significant effect on a substantial number of small entities. Therefore, DOE has prepared an IRFA for this rulemaking. The IRFA describes potential impacts on small businesses associated with walk-in cooler and freezer testing requirements.

DOE has transmitted a copy of this IRFA to the Chief Counsel for Advocacy of the Small Business Administration for review.

1. Reasons for the Proposed Rule

Title III of the EPCA sets forth a variety of provisions designed to improve energy efficiency. Part B of Title III (42 U.S.C. 6291–6309) provides for the Energy Conservation Program for Consumer Products Other Than Automobiles. NECPA (Pub. L. 95–619) amended EPCA to add Part C of title III, which established an energy conservation program for certain industrial equipment. (42 U.S.C. 6311–6317) (These parts were subsequently redesignated as Parts A and A–1, respectively, for editorial reasons.) Section 312 of EISA 2007 further amended EPCA by adding certain equipment to this energy conservation program, including walk-in coolers and walk-in freezers (collectively ''walk-in equipment'' or ''walk-ins''), the subject of this rulemaking. (42 U.S.C 6311(1), (2), 6313(f) and 6314(a)(9)) The proposed rule would establish a test procedure for walk-in coolers and walk-in freezers.

2. Objectives of, and Legal Basis for, the Proposed Rule

Under EPCA, the overall energy conservation program consists essentially of the following parts: Testing, labeling, and Federal energy conservation standards. The testing requirements for covered equipment consist of test procedures, prescribed under EPCA. The test procedures, if adopted, would be used in one of three ways: (1) Any data from the use of the test procedure, would be used by DOE as a basis for developing standards for walk-in equipment; (2) the procedure would be used by DOE when determining equipment compliance with those standards; and (3) manufacturers of covered equipment would be required to use the procedure as the basis for establishing that their equipment complies with the relevant energy conservation standards promulgated pursuant to EPCA and when making representations regarding equipment efficiency.

Section 343 of EPCA (42 U.S.C. 6314) sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures for covered equipment. That provision requires that the test procedures promulgated by DOE be reasonably designed to produce test results which reflect energy efficiency, energy use, and estimated operating costs of the covered equipment during a representative average use cycle. It also requires that the test procedure not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) Further information concerning the background of this rulemaking is provided in Section I of this preamble.

3. Description and Estimated Number of Small Entities Regulated

Small businesses, as defined by the Small Business Administration (SBA) for the walk-in cooler and freezer manufacturing industry, are manufacturing enterprises with 750 employees or fewer. DOE used the small business size standards published on January 31, 1996, as amended, by the SBA to determine whether any small entities would be required to comply with the rule. 61 FR 3286; see also 65 FR 30836, 30850 (May 15, 2000), as amended at 65 FR 53533, 53545 (September 5, 2000). The size standards are codified at 13 CFR Part 121. The standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at *http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf.* Walk-in cooler and freezer equipment manufacturing is classified under NAICS 333415, Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing.

DOE reviewed AHRI's listing of commercial refrigeration equipment manufacturer members and surveyed the industry to develop a list of domestic manufacturers. DOE also asked stakeholders and AHRI representatives within the industry if they were aware of any other small business manufacturers. DOE then examined publicly available data, including regulatory databases such as state databases and the National Sanitation Foundation (NSF) Section 7 database. DOE identified at least 37 small manufacturers of walk-in cooler and freezer envelopes, and at least 5 small manufacturers of walk-in cooler and freezer refrigeration systems. However, some manufacturers that DOE interviewed indicated that there could be many more small business manufacturers than were publicly listed. Such unlisted manufacturers could be very small (< 50 employees) and serve only a local market. They also may not submit any information to state or national regulators such as NSF. Therefore, DOE believes there may be more affected small entities than it estimated and seeks comment on the number of small entities that may be impacted by the test procedure.

4. Description and Estimate of Compliance Requirements

Potential impacts of the proposed test procedures on manufacturers, including small businesses, come from impacts associated with the cost of testing. In this test procedure NOPR, DOE proposes measures to reduce the financial burden of testing on all manufacturers, including small business manufacturers. First, where the procedure gives manufacturers options in terms of materials, equipment, or methodology to be used in performing the test, DOE proposes to allow manufacturers to use the lowest-cost option, where possible. For instance, ASTM E741–06 allows manufacturers to use any of about 12 tracer gases. DOE specifies a tracer gas to ensure that all manufacturers report at the same accuracy, but specifies the use of carbon dioxide, which would be the lowest cost option. Second, DOE proposes to reduce the total number of tests manufacturers would have to perform by allowing them to group similar equipment into a single family, or basic model, and only requiring them to test one unit of each basic model. (See section III.A.1 for a more detailed discussion of the basic model proposal.)

The proposed test procedure for envelopes would require manufacturers to perform testing in accordance with two industry test standards: ASTM C1303–08, ''Standard Test Method of Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation,'' and ASTM E741–06, ''Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution.'' DOE spoke with industry experts to determine the approximate cost of each test and determined that a test using ASTM C1303–08 costs between approximately $5,000 and $10,000, and a test using ASTM E741–06 costs between $1,000 and $5,000. A typical manufacturer would have approximately 8 basic models, so the total cost of compliance would be approximately $84,000.

The proposed test procedure for refrigeration systems would require manufacturers to perform testing in accordance with a single industry test standard: AHRI Standard 1250P–2009, ''2009 Standard for Performance Rating of Walk-In Coolers and Freezers.'' Because this test was recently developed by the industry and has not yet been widely used to test refrigeration systems, DOE could not determine how much the test currently costs. However, DOE researched the cost of other, similar standards and subsequently estimated that a test using AHRI Standard 1250P–2009 would likely cost approximately $5,000. A typical refrigeration manufacturer could have approximately 50 basic models, making the total cost of compliance approximately $250,000.

Because the cost of running each test is the same for all manufacturers, and because DOE has proposed measures to reduce burden on all manufacturers, DOE believes that all manufacturers would incur comparable costs as a result of the proposed test procedures. However, DOE does not expect that small manufacturers would have fewer basic models than large manufacturers, because the equipment is highly customized throughout the industry. A small manufacturer could have the same total cost of testing as a large manufacturer, but this cost would be a higher percentage of a small manufacturer's annual revenues. Thus, DOE cannot certify that the differential impact associated with walk-in cooler and freezer test procedures on small businesses would not be significant.

5. Duplication, Overlap, and Conflict With Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the rule being considered today.

6. Significant Alternatives to the Rule

DOE considered a number of alternatives to the proposed test procedure, including test procedures that incorporate industry test standards other than the three proposed standards, ASTM C1303–08, ASTM E741–06, and AHRI Standard 1250P–2009, described above. Instead of requiring ASTM C1303–08 for testing the long-term thermal properties of insulation, DOE could require only ASTM C518–04, ''Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus,'' which tests the thermal properties of insulation at a certain point in time (*i.e.,* the point of manufacture). (Because ASTM C1303–08 incorporates ASTM C518–04, requiring ASTM C1303–08 is consistent with the statutory requirement for basing measurement of the thermal conductivity of the insulation on ASTM C518–04.) (42 U.S.C. 6314(a)(9)(A)) A test of ASTM C518–04 alone costs approximately $500–$1,000. However, DOE is considering ASTM C1303 for other reasons; namely, the concern that ASTM C518–04 alone does not capture the performance characteristics of a walk-in over the period of its use, because it does not account for significant changes in the thermal properties of insulation over time. For more discussion on this issue, see Section III.B.2.a.

DOE also considered ASTM E1827–96(2007), ''Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door,'' instead of ASTM E741–06, for testing infiltration. ASTM E1827–96(2007) costs about $300–$500 for a single test. However, DOE believes that ASTM E1827–96(2007) is not appropriate for walk-ins because it is conducted by placing test equipment in the door, and thus does not account for in infiltration through the door, which is a major component of infiltration in walk-ins. In addition, it is not intended for testing envelope systems, such as a walk-in, that have a large temperature difference between the internal and external air. Therefore, to complete a blower-door test, the walk-in would not be able to be tested at or close to operational temperatures, resulting in a test that does not accurately reflect its performance. For more discussion on this issue, see Section III.B.2.b.

In the framework document, DOE considered adapting an existing test procedure for commercial refrigeration equipment, such as ARI Standard 1200–2006, ''Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets,'' as an alternative to AHRI Standard 1250P–2009. The two tests are based on a similar methodology for rating refrigeration equipment in general, but ARI Standard 1200–2006 requires testing at only one set of ambient conditions, whereas AHRI Standard 1250P–2009 requires testing at 3 sets of ambient conditions for refrigeration systems with the condensing units located outdoors. The additional time required to test the system at 3 sets of conditions would incur additional cost and could make AHRI Standard 1250P–2009 more burdensome than ARI Standard 1200–2006. However, DOE believes that AHRI Standard 1250P–2009 is more appropriate for testing walk-ins than ARI Standard 1200–2006. A test procedure based on ARI Standard 1200–2006 would require the entire walk-in to be tested as a whole, but manufacturers might not have a large enough test facility to make the measurements necessary for the ARI 1200–2006 test procedure in a controlled environment. Also, the refrigeration system is often manufactured separately from the insulated envelope. In this case, whoever assembled the two components would bear the burden of conducting ARI 1200–2006; this party might not be the manufacturer of the refrigeration system. In contrast, AHRI 1250P–2009 tests only the refrigeration system. It does not require a larger test chamber than other, similar tests, and can be conducted by the manufacturer of the refrigeration system. Furthermore, because AHRI 1250P–2009 requires the system to be tested at 3 ambient temperatures, it captures energy savings from features (for example, floating head pressure) that allow the system to use less energy at lower ambient temperatures. For more discussion on this issue, see Section III.A.2.

DOE requests comment on the impacts to small business manufacturers for these and any other possible alternatives to the proposed rule. DOE will consider any comments received regarding impacts to small business manufacturers for all the alternatives identified.

D. Review Under the Paperwork Reduction Act

Today's proposed rule contains no record-keeping requirements. Therefore, today's notice of proposed rulemaking would not impose any new reporting requirements requiring clearance by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* The Department recognizes, however, that if it adopts standards for walk-in coolers and walk-in freezers, once the standards become operative, manufacturers may become subject to record-keeping requirements associated with compliance with the standards. Therefore, the Department will comply with the record-keeping requirements of the Paperwork Reduction Act if and when energy conservation standards are adopted.

E. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and tribal governments and the private sector. With respect to a proposed regulatory action that may result in the expenditure by State, local and tribal governments, in the aggregate, or by the private sector of $100 million or more (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish estimates of the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA (62 FR 12820) (also available at *http://www.gc.doe.gov*). The proposed rule published today does not provide for any Federal mandate likely to result in an aggregate expenditure of $100 million or more. Therefore, the UMRA does not require a cost benefit analysis of today's proposal.

F. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This proposed rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

G. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (August 4, 1999) imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations (65 FR 13735). DOE has examined today's proposed rule and has determined that it does not preempt State law and does not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) No further action is required by Executive Order 13132.

H. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform'' (61 FR 4729, February 7, 1996), imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity, (2) write regulations to minimize litigation, and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. Section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation (1) Clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this proposed rule meets the relevant standards of Executive Order 12988.

I. Review Under the Treasury and General Government Appropriations Act, 2001

The Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (February 22, 2002), and DOE's guidelines were published at 67 FR 62446 (October 7, 2002). DOE has reviewed today's notice under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

J. Review Under Executive Order 13211

Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,'' 66 FR 28355 (May 22, 2001) requires Federal agencies to prepare and submit to the Office of Information and Regulatory Affairs (OIRA), Office of Management and Budget, a Statement of Energy Effects for any proposed significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgated or is expected to lead to promulgation of a final rule, and that (1) Is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use. Today's regulatory action is not a significant regulatory action under Executive Order 12866. Moreover, it would not have a significant adverse effect on the supply, distribution, or use of energy. The Administrator of OIRA also did not designate today's action as a significant energy action. Therefore, it is not a significant energy action, and DOE has not prepared a Statement of Energy Effects.

K. Review Under Executive Order 12630

DOE has determined pursuant to Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988) that this proposed rule would not result in any takings which might require compensation under the Fifth Amendment to the United States Constitution.

L. Review Under Section 32 of the Federal Energy Administration (FEA) Act of 1974

Under section 301 of the Department of Energy Organization Act (Pub. L. 95–91), DOE must comply with section 32 of the Federal Energy Administration Act of 1974, as amended by the Federal Energy Administration Authorization Act of 1977. (15 U.S.C. 788) Section 32 provides in part that, where a proposed rule contains or involves use of commercial standards, the rulemaking must inform the public of the use and background of such standards. The rule proposed in this notice incorporates testing methods contained in the following commercial standards: ASTM C1303–08, ''Standard Test Method of Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation;'' ASTM E741–06, ''Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution;'' and AHRI Standard 1250P, ''2009 Standard for Performance Rating of Walk in Coolers and Freezers.'' The Department has evaluated these standards and is unable to conclude whether they fully comply with the requirements of section 32(b) of the Federal Energy Administration Act, *i.e.,* whether they were developed in a manner that fully provides for public participation, comment, and review. As required by section 32(c) of the Federal Energy Administration Act, of 1974, as amended, DOE will consult with the Attorney General and the Chairman of the Federal Trade Commission before prescribing a final rule concerning the impact on competition of requiring manufacturers to use the methods contained in these standards to test walk-in equipment.

V. Public Participation

A. Attendance at Public Meeting

The time, date, and location of the public meeting are provided in the **DATES** and **ADDRESSES** sections at the beginning of this document. Anyone who wants to attend the public meeting must notify Ms. Brenda Edwards at (202) 586–2945. As explained in the **ADDRESSES** section, foreign nationals visiting DOE headquarters are subject to advance security screening procedures.

B. Procedure for Submitting Requests To Speak

Any person who has an interest in the topics addressed in this notice, or who is a representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation at the public meeting. Such persons may hand-deliver requests to speak to the address shown in the **ADDRESSES** section at the beginning of this notice between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Requests may also be sent by mail or email to: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121, or *Brenda.Edwards@ee.doe.gov*. Persons who wish to speak should include in their request a computer diskette or CD in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format that briefly describes the nature of their interest in this rulemaking and the topics they wish to discuss. Such persons should also provide a daytime telephone number where they can be reached.

DOE requests that those persons who are scheduled to speak submit a copy of their statements at least one week prior to the public meeting. DOE may permit any person who cannot supply an advance copy of this statement to participate, if that person has made alternative arrangements with the Building Technologies Program in advance. When necessary, the request to give an oral presentation should ask for such alternative arrangements.

C. Conduct of Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also employ a professional facilitator to aid discussion. The public meeting will be conducted in an informal, conference style. The meeting will not be a judicial or evidentiary public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). Discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws is not permitted.

DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. A court reporter will record the proceedings and prepare a transcript.

At the public meeting, DOE will present summaries of comments received before the public meeting, allow time for presentations by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant may present a prepared general statement (within time limits determined by DOE) before the discussion of specific topics. Other participants may comment briefly on any general statements. At the end of the prepared statements on each specific topic, participants may clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions from DOE and other participants. DOE representatives may also ask questions about other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of procedures needed for the proper conduct of the public meeting.

DOE will make the entire record of this proposed rulemaking, including the transcript from the public meeting, available for inspection at the U.S. Department of Energy, 6th Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Anyone may purchase a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding the proposed rule no later than the date provided at the beginning of this notice. Comments, data, and information submitted to DOE's e-mail address for this rulemaking should be provided in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format. Interested parties should avoid the use of special characters or any form of encryption, and wherever possible, comments should include the electronic signature of the author. Absent an electronic signature, comments submitted electronically must be followed and authenticated by submitting a signed original paper document to the address provided at the beginning of this notice. Comments, data, and information submitted to DOE via mail or hand delivery/courier should include one signed original paper copy. No telefacsimiles (faxes) will be accepted.

According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies: One copy of the document including all the information believed to be confidential, and one copy of the document with the information believed to be confidential deleted. DOE will make its own determination as to the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include (1) A description of the items, (2) whether and why such items are customarily treated as confidential within the industry, (3) whether the information is generally known by or available from other sources, (4) whether the information has previously been made available to others without obligation concerning its confidentiality, (5) an explanation of the competitive injury to the submitting person which would result from public disclosure, (6) a date upon which such information might lose its confidential nature due to the passage of time, and (7) why disclosure of the information would be contrary to the public interest.

E. Issues on Which DOE Seeks Comment

DOE is particularly interested in receiving comments on the following issues:

1. Test Procedure Improvements

DOE requests comments on improvements in the test procedures that it should consider. In submitting comments, interested parties should state the nature of the recommended modification and an explanation of how it improves upon the test procedure proposed in this NOPR. See section II for details.

2. Basic Model

Because walk-in equipment tends to be highly customized, DOE is considering allowing manufacturers to group similar walk-in equipment under a single ''basic model'' and only subjecting one unit of each basic model to testing. DOE will use the term ''basic model'' to represent a single family of walk-in equipment, consisting of walk-in equipment or models of equipment that do not have any differentiating electrical, physical, or functional features that significantly affect energy consumption characteristics. DOE requests comments on the proposed basic model approach. See section III.A.1 for details.

3. Separate Envelope and Refrigeration Tests

For any walk-in, two different manufacturers may make the two main components: The envelope, or insulated box, and the refrigeration system. In this notice, DOE proposes separate test procedures for the envelope and the refrigeration system. The envelope manufacturer would be responsible for testing the envelope according to the envelope test procedure, and the refrigeration system manufacturer would be responsible for testing the refrigeration system according to the refrigeration system test procedure. The purpose of this provision is to accurately reflect the structure of the walk-in market and assign testing responsibilities to the equipment manufacturers. DOE requests comments on the proposed approach to develop separate test procedures. See section III.A.4 for details.

4. Definition of Envelope

DOE requests comments on the following definition of ''envelope:'' ''(1) a piece of equipment that is the portion of a walk-in cooler or walk-in freezer that isolates the interior, refrigerated environment from the ambient, external environment; and (2) all energy-consuming components of the walk-in cooler or walk-in freezer that are not part of its refrigeration system.'' See section III.B.1 for details.

5. Effect of Impermeable Skins on Long-Term R-Value

DOE received many comments on the framework document regarding long-term R-value. After researching the issue, DOE determined that the R-value of insulating foams diminish after manufacture at rates that vary by material type and environmental conditions. Diffusion of gases and moisture infiltration are the key mechanisms of R-value decline. Many manufacturers seek to prevent or delay diffusion and moisture infiltration by sealing the foam in a ''skin,'' typically a metal material. DOE received comments suggesting that these skins can be made fully impermeable while other comments argued that full impermeability cannot be achieved due to imperfect sealing at panel joints, imperfect adherence of foam to metal during manufacture, deliberate punctures for fixtures and shelving, and/or inadvertent punctures that typically occur in the field. DOE requests feedback on this issue, including the submission of test results on the impact of impermeable skins on long-term R-value. Specifically, DOE requests that interested parties submit or identify any peer-reviewed, published data pertaining to the efficacy of skins in preventing or delaying R-value decline. See section III.B.2.a for details.

6. Measuring Long-Term R-Value Using American Society for Testing and Materials (ASTM) C1303–08

DOE proposes accounting for R-value decline due to diffusion of gases by requiring manufacturers to condition their foam prior to testing. DOE proposes requiring manufacturers to condition foam using ASTM C1303–08, which conditions foam using an accelerated aging method prior to testing its R-value. Because ASTM C1303–08 uses ASTM C518–2004, using ASTM C1303–08 would be consistent with EPCA. (42 U.S.C. 6314(a)(9)(A)(ii)) DOE requests feedback on the proposal to require conditioning and testing foam using ASTM C1303–08. DOE recognizes that ASTM C1303–08 is designed for unfaced and permeably faced foams rather than the impermeably faced foams typical of walk-ins. DOE requests feedback on the use of ASTM C1303–08 for foams that will be impermeably faced.

DOE is considering several exceptions and clarifications to ASTM C1303–08 to satisfy requirements of EPCA and to make the test procedure more applicable to walk-ins. DOE requests feedback on the number of samples and sample thicknesses, the use of interpolation of results for foam thicknesses within the specified ±0.5 inch range, and the use of the core stack R-value out of a sample size of three stacks for the purpose of calculating walk-in energy use.

Lastly, ASTM C1303–08 cannot be used for non-foam materials, but DOE is not aware of any non-foam materials currently being used as insulation in walk-in coolers or freezers. DOE requests comment on whether non-foam technologies, such as vacuum insulated panels or aerogels, are likely to be commercially available for walk-ins within the next 5 years. See section III.B.2.a for details.

7. Infiltration

Air infiltration causes a substantial amount of heat gain through the envelope. After evaluating several methods of testing and measuring the air infiltration, DOE proposes requiring ASTM E741–06, also referred to as the gas tracer method, as the test procedure for measuring steady-state infiltration and the effectiveness of infiltration reduction devices (for air infiltration unrelated to door opening events). Because door opening also contributes to infiltration, DOE proposes accounting for this infiltration pathway. DOE does not, however, propose to require manufacturers to individually measure the infiltration from door opening events, due to the complexity of this type of testing and the availability of accurate analytical models, which would make a test procedure very difficult to implement. DOE proposes using analytical methods based on ASHRAE fundamentals as well as assumed door-opening frequency and duration and the measured infiltration barrier effectiveness to calculate the air infiltration associated with each door-opening event. DOE requests comments on the proposed test method for steady-state infiltration. DOE requests input and feedback on the calculations and assumptions proposed for determining infiltration from door-opening events. See section III.B.2.b for details on the proposed analytical methods.

8. Nominal Coefficient of Performance of Refrigeration

In developing a test procedure for the envelope alone, without a refrigeration system, DOE had to determine the energy consumption associated with heat gain through the envelope due to conduction and infiltration. DOE proposes to assume a nominal EER for the refrigeration system to convert the heat gain through the box into a measure of the energy consumption of a theoretical refrigeration system that would be removing this heat from the box. For comparison purposes, DOE recommends that the EER be 12.4 Btu per watt hour (Btu/Wh) for coolers and 6.3 Btu/Wh for freezers because these are typical EER values. DOE requests comments on this proposal and on the assumed value for the EER. See section III.B.3.a for details.

9. Measuring the U-Value of Glass

Because conduction through glass components can be a significant source of heat transfer through walk-in envelopes, DOE seeks to order to account for improvements in glass performance in the test procedure. DOE proposes two options for manufacturers: (1) If manufacturers of glass doors used in walk-ins participate in the NFRC rating program, the performance of the door shall be simply read from its label and used for calculations in this test procedure. If glass door manufacturers do not participate in the NFRC rating program, then (2) DOE proposes to require manufacturers to use the LBNL's publicly available Window 5.2 software package to calculate glass door performance. DOE seeks comment on the availability of performance data on glass products used in walk-in applications, glass component manufacturers' participation in third party certification programs such as NFRC, and the proposed method for predicting the thermal performance of glass components using Window 5.2. See section III.B.3.b for more information.

10. Floor R-Value

EPCA does not require walk-in cooler floors to meet a specific R-value. In many instances, walk-in coolers are shipped without additional insulating floors and are simply placed on top of an existing surface, such as a concrete slab. Since concrete is the floor surface most commonly used with floorless walk-in coolers DOE is considering using the R-value of 6-inch concrete to calculate energy lost through these floors. DOE proposes using an R-value of 0.6 ft^2-° F-hr/Btu for 6-inch concrete. Since walk-in freezers are required to have a floor insulation of R–28, DOE will assume this R-value for purposes of calculating the energy loss through walk-in freezer floors if the manufacturer does not provide any additional insulating surface. DOE requests comments on these assumptions. See section III.B.3.b for details.

11. Electrical Duty Cycle

As part of the envelope test procedure, DOE recommends calculating the electricity consumption of lights, sensors, and other miscellaneous electrical devices not considered part of the refrigeration equipment using name-plate rating and an assumed daily operation. DOE incorporates assumed duty cycles of lights, anti-sweat heaters, and other devices based on whether they are controlled by a preset control system. While these assumptions may not reflect the actual behaviorally related energy consumption, they will provide a means for comparison. DOE requests comments on whether the duty cycle assumptions are appropriate. See section III.B.3.d for details.

12. Normalization Factor

For the envelope test procedure, DOE proposes to normalize the energy consumption by a certain factor related to the size of the walk-in so that manufacturers of larger walk-ins and walk-ins with glass doors are not unfairly penalized. DOE believes that the surface area of the envelope is an appropriate normalization factor, because surface area is the key geometric characteristic related to both conduction and infiltration and is particularly important as the ratio of glass door area to wall area increases. DOE requests comments on the proposal to normalize the energy consumption by the surface area of the walk-in. See section III.B.3.e for details.

13. Daily Energy Consumption Coefficients

In order to compare envelopes that are similar enough to be included in the same basic model but are not identical, the test procedure allows for calculating Daily Energy Consumption Coefficients, or DECCs, using test results from a particular envelope within a basic model, and then applying these DECCs to other envelopes within a basic model to calculate the energy consumption of the other units. DECCs are essentially scaling factors that allow a manufacturer to change certain parameters of an envelope and calculate the corresponding change in energy consumption. DOE believes that this approach would reduce the testing burden on manufacturers because it would not require manufacturers to test every unit produced with slight variations due to customer specification. DOE requests comment on this rating methodology. For formulas and more information, see section III.B.3.f.

14. Definition of Refrigeration System

DOE requests comments on the following definition of ''refrigeration system:'' ''the mechanism used to create the refrigerated environment in the interior of a walk-in cooler or freezer, consisting of an integrated single-package refrigeration unit, or a split system with separate unit cooler and condensing unit sections, or a unit cooler that is connected to a central rack system; and including all controls and other components integral to the operation of this mechanism.'' See section III.C.1 for details.

15. Measurements and Calculations of Energy Use of Refrigeration Systems

The test procedure DOE proposes to adopt, AHRI Standard 1250P–2009, determines the annual walk-in energy factor, or AWEF, which is a measure of the efficiency of a walk-in's refrigeration system. However, DOE is required by EPCA to establish ''a test procedure to measure * * * energy use.'' (42 U.S.C. 6314(a)(9)(B)(i)) In light of this requirement, DOE proposes that manufacturers determine both the AWEF and the annual energy consumption of their equipment using the test procedure, which will enable the test procedure to be consistent with the requirements of EPCA to develop test procedures that measure the energy consumption of walk-in equipment. DOE is considering satisfying the statutory requirement by deriving the energy consumption of the walk-in refrigeration system from data obtained when the test procedure is performed. DOE's derivation process, and further information, can be found in section III.C.4.

16. Impacts on Small Businesses

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. Upon examination of this NOPR, DOE could not certify that the rule, if promulgated, would not have a significant economic impact on a substantial number of small entities; therefore, DOE prepared an IRFA for this rule. DOE requests comment on the number of small businesses affected by the proposed rule, and seeks comment on impacts to small business manufacturers for any possible alternatives to the proposed rule. More information, along with the text of the IRFA, can be found in section IV.C.

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this proposed rule.

List of Subjects in 10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation, Reporting and recordkeeping requirements.

Issued in Washington, DC, on December 14, 2009.

Cathy Zoi,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons stated in the preamble, DOE proposes to amend part 431 of chapter II of title 10, of the Code of Federal Regulations, to read as set forth below.

PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

1. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291–6317.

2. Section 431.302 is amended by adding, in alphabetical order, definitions for ''Basic model,'' ''Envelope,'' ''Refrigeration system,'' and ''Walk-in equipment'' to read as follows:

§ 431.302 Definitions concerning walk-in coolers and walk-in freezers.

Basic Model means all units of a given type of walk-in equipment manufactured by a single manufacturer, and—

(1) With respect to envelopes, which do not have any differing construction methods, materials, components, or other characteristics that significantly affect the energy consumption characteristics.

(2) With respect to refrigeration systems, which have the same primary energy source and which do not have any differing electrical, physical, or functional characteristics that significantly affect energy consumption.

Envelope means (1) the portion of a walk-in cooler or walk-in freezer that isolates the interior, refrigerated environment from the ambient, external environment; and (2) all energy-consuming components of the walk-in cooler or walk-in freezer that are not part of its refrigeration system.

Refrigeration system means the mechanism used to create the refrigerated environment in the interior of a walk-in cooler or freezer, consisting of an integrated single-package refrigeration unit, or a split system with separate unit cooler and condensing unit sections, or a unit cooler that is connected to a central rack system; and including all controls and other components integral to the operation of this mechanism.

* * * * *

Walk-in equipment means either the envelope or the refrigeration system of a walk-in cooler or freezer.

3. Section 431.303 is amended by adding new paragraphs (b)(2), (b)(3), and (c) to read as follows:

§ 431.303 Materials incorporated by reference.

* * * * *

(b) * * *

(2) ASTM C1303–08, Standard Test Method of Predicting Long Term Thermal Resistance of Closed-Cell Foam Insulation, approved September 15, 2008, IBR approved for § 431.304.

(3) ASTM E741–06, Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution, approved October 1, 2006, IBR approved for § 431.304.

(c) *AHRI.* Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, (703) 600–0366, or *http://www.ahrinet.org.*

(1) AHRI Standard 1250P–2009, 2009 Standard for Performance Rating of Walk-In Coolers and Freezers, approved September 2009, IBR approved for § 431.304.

(2) Reserved.

4. Section 431.304 is revised to read as follows:

§ 431.304 Uniform test method for the measurement of energy consumption of walk-in coolers and walk-in freezers.

(a) *Scope.* This section provides test procedures for measuring, pursuant to EPCA, the energy consumption of walk-in coolers and walk-in freezers.

(b) *Testing and Calculations.*

(1) Determine the energy consumption of walk-in cooler and walk-in freezer envelopes by conducting the test procedure specified in Appendix A to this subpart.

(2) Determine the U-value of glass components from the product label in compliance with the National Fenestration Rating Council's Product Certification Program, PCP–2007, or by using the Window 5.2 software to calculate the performance of the glass.

(3) Determine the Annual Walk-in Efficiency Factor of walk-in cooler and walk-in freezer refrigeration systems by conducting the test procedure set forth in AHRI Standard 1250P–2009 (incorporated by reference, see § 431.303).

(4) Determine the energy consumption of walk-in cooler and walk-in freezer refrigeration systems by:

(i) For refrigeration systems with the condensing unit located inside a conditioned space, performing the following calculations for coolers and freezers, respectively:

$$\text{Annual Energy Consumption (coolers)} = \frac{0.30 \times \dot{q}_{ss}(90\ ^{\circ}\text{F}) \times 8760}{\text{Annual Walk-in Efficiency Factor}}$$

$$\text{Annual Energy Consumption (freezers)} = \frac{0.53 \times \dot{q}_{ss}(90\ ^{\circ}\text{F}) \times 8760}{\text{Annual Walk-in Efficiency Factor}}$$

Where q_{ss} (90 °F) is the steady state net refrigeration capacity measured at an ambient condition of 90 °F, and the Annual Walk-In Efficiency Factor is calculated from the results of the test procedures set forth in

AHRI Standard 1250P–2009 (incorporated by reference, see § 431.303).

(ii) For refrigeration systems with the condensing unit located outdoors, performing the following calculations for coolers and freezers, respectively:

$$\text{Annual Energy Consumption (coolers)} = \frac{\sum_{j=1}^{n}\left[0.24\times\dot{q}_{ss}(95\ ^{o}F)+0.06\times\frac{\dot{q}_{ss}(95\ ^{o}F)\times(t_j-35)}{60}\right]\times n_j}{\text{Annual Walk-in Efficency Factor}}$$

$$\text{Annual Energy Consumption (freezers)} = \frac{\sum_{j=1}^{n}\left[0.28\times\dot{q}_{ss}(95\ ^{o}F)+0.25\times\frac{\dot{q}_{ss}(95\ ^{o}F)\times(t_j+10)}{105}\right]\times n_j}{\text{Annual Walk-in Efficency Factor}}$$

Where q_{ss} (95 °F) is the steady state net refrigeration capacity measured at an ambient condition of 95 °F; t_j and n_j represent the outdoor temperature at each bin j and the number of hours in each bin j, respectively, for the temperature bins listed in Table D1 of AHRI Standard 1250P–2009 (incorporated by reference, see § 431.303); and the Annual Walk-In Efficiency Factor is calculated from the results of the test procedures set forth in AHRI Standard 1250P–2009 (incorporated by reference, see § 431.303).

(iii) For refrigeration systems consisting of a unit cooler connected to a rack system, performing the following calculations for coolers and freezers, respectively:

$$\text{Annual Energy Consumption (coolers)} = \frac{0.30\times\dot{q}_{mix,evap}\times 8760}{\text{Annual Walk-in Efficiency Factor}}$$

$$\text{Annual Energy Consumption (freezers)} = \frac{0.53\times\dot{q}_{mix,evap}\times 8760}{\text{Annual Walk-in Efficiency Factor}}$$

Where $q_{mix,evap}$ is the net capacity of the evaporator coil, determined by testing the unit cooler at the 25 °F suction dewpoint for a cooler and the −20 °F suction dewpoint for a freezer, at the maximum evaporator fan speed, according to AHRI standard 1250P–2009 (incorporated by reference, see § 431.303); and the Annual Walk-in Efficiency Factor is calculated from the results of the test procedures set forth in AHRI Standard 1250P–2009 (incorporated by reference, see § 431.303).

5. Appendix A is added to subpart R of part 431 to read as follows:

Appendix A to Subpart R of Part 431—Uniform Test Method for the Measurement of Energy Consumption of the Envelopes of Walk-In Coolers and Walk-In Freezers

1.0 Scope

This appendix covers the test requirements used to measure the energy consumption of the envelopes of walk-in coolers and walk-in freezers.

2.0 Definitions

The definitions contained in § 431.302 are applicable to this appendix.

2.1 Additional Definitions

(a) Unless explicitly stated otherwise, the surface area for all measurements is the area as measured on the external surface of the walk-in.

(b) A device or control system that ''automatically'' opens and closes doors without direct user contact (*i.e.*, a motion sensor that senses when a forklift is approaching the entrance to a door, opens, and then closes after the forklift has passed).

(c) Unless explicitly stated otherwise, all calculations and test procedure measurements shall use the temperature and relative humidity data shown in Table A.1. For installations where two or more walk-in envelopes share any surface(s), the ''external conditions'' of the shared surface(s) should reflect the internal conditions of the neighboring walk-in.

TABLE A.1—TEMPERATURE AND RELATIVE HUMIDITY CONDITIONS

	Value	Units
Internal Conditions (cooled space within envelope)		
Cooler:		
Dry Bulb Temperature	35	F
Relative Humidity	60	%
Freezer:		
Dry Bulb Temperature	−10	F
Relative Humidity	60	%
External Conditions (space external to the envelope)		
Freezer and Cooler:		
Dry Bulb Temperature	75	F
Relative Humidity	40	%

3.0 Test Apparatus and General Instructions

3.1 Conduction Heat Gain

3.1.1 Glass Doors

(a) All dimensional measurements for glass doors include the door frame and glass.

(b) Calculate the individual and total glass door surface area (A_{glass}) as follows:

$$A_{glass,i} = \left(W_{glass,\,i} \times H_{glass,\,i}\right) \times n_i \qquad (3\text{-}1)$$

$$A_{glass,tot} = \sum_{1}^{i} \left(W_{glass,\,i} \times H_{glass,\,i}\right) \times n_i \qquad (3\text{-}2)$$

Where:

i = index for each type of unique glass door used in cooler or freezer being tested,

n_i = number of identical glass doors of type i,

$W_{glass,i}$ = width of glass door (including door frame), and

$H_{glass,i}$ = height of glass door (including door frame).

(c) Calculate the temperature differential(s) ΔT_i for each unique glass door (°F) as follows:

$$\Delta T_i = T_{DB,int,i} - T_{DB,ext,i} \qquad (3\text{-}3)$$

Where:

i = Index for each type of unique glass door used in cooler or freezer being tested,

$T_{DB,int,i}$ = dry-bulb air temperature inside the cooler or freezer, °F

$T_{DB,ext,i}$ = dry-bulb air temperature external to cooler or freezer, °F

(d) Calculate the conduction load through the glass doors, ($Q_{cond\text{-}glass,door}$):

$$Q_{cond\text{-}glass,door} = \sum_{1}^{i} A_{glass,i} \times \Delta T_i \times U_{glass,i} \times n_i \qquad (3\text{-}4)$$

Where:

n_i = number of identical glass doors of type i;

$U_{glass,i}$ = thermal transmittance, U-value of the door, of type i, Btu/h-ft²-°F;

$A_{glass,i}$ = total surface area of all walk-in glass doors of type i, ft²; and

ΔT_I = temperature differential between refrigerated and adjacent zones, °F.

3.1.2 Wall Glass and Doors With Inset Glass

(a) Calculate the individual and total glass surface area ($A_{glass,wall}$), as follows:

$$A_{glass,wall,i} = \left(W_{glass,wall,i} \times H_{glass,wall,i}\right) \times n_i \qquad (3\text{-}5)$$

$$A_{glass,wall,tot} = \sum_{1}^{i} \left(W_{glass,wall,i} \times H_{glass,wall,i}\right) \times n_i \qquad (3\text{-}6)$$

Where:

i = index for each type of unique glass door used in cooler or freezer being tested,

n_i = number of identical glass walls or insets of type i,

$W_{glass,wall,,i}$ = width of glass wall (including glass framing)

$H_{glass,wall,i}$ = height of glass wall (including glass framing)

(b) Calculate the temperature differential(s) $\Delta T_{glass,wall,i}$ for each unique glass wall (°F), as follows:

$$\Delta T_{glass,wall,i} = T_{DB,int,glass,wall,i} - T_{DB,ext,glass,wall,i} \qquad (3\text{-}7)$$

Where:

i = Index for each type of unique glass door used in cooler or freezer

$T_{DB,int,glass,wall,i}$ = dry-bulb air temperature inside the cooler or freezer, °F

$T_{DB,ext,glass,wall,i}$ = dry-bulb air temperature external to cooler or freezer, °F

(c) Calculate the conduction load through the glass walls and glass insets, ($Q_{cond\text{-}glass,wall}$), as follows:

$$Q_{cond\text{-}glass,wall} = \sum_{1}^{i} A_{glass,wall,i} \times \Delta T_{glass,wall,i} \times U_{glass,wall,i} \times n_i \qquad (3\text{-}8)$$

Where:

n_i = number of identical glass walls or insets of type i;

$U_{glass,wall,i}$ = thermal transmittance, U-value of the glass wall, of type i, Btu/h-ft²-°F;

$A_{glass,wall,i}$ = total surface area of all walk-in glass walls and insets of type i, ft²; and

$\Delta T_{glass,wall,i}$ = temperature differential between refrigerated and adjacent zones, °F.

3.1.3 Non-Glass Envelope Components

(a) Calculate the total surface area of the walk-in non-glass envelope ($A_{non\text{-}glass,tot}$), as follows:

$$A_{non\text{-}glass,tot} = \sum_{1}^{i} A_{walls,i} + \sum_{1}^{j} A_{floor,j} + \sum_{1}^{k} A_{ceiling,k} + \sum_{l}^{l} A_{non\text{-}glass\ doors,l} \qquad (3\text{-}9)$$

Where:

i,j,k,l = number of identical surface area regions of walls, floors, ceilings and non-glass doors, respectively, comprised of the same thickness and underlying materials and temperature differential—for example, if a walk-in has wall sections that are of two different thickness or of two different foam insulation products, i=2;

$A_{walls,i}$ = area of walls, of thickness and underlying materials of type i;

$A_{floor,j}$ = area of floor, of thickness and underlying materials of type j;

$A_{ceiling,k}$ = area of ceiling, of thickness and underlying materials of type k; and

$A_{non\text{-}glass\ door,l}$ = area of doors, of thickness and underlying materials of type l.

(b) Determine the R-value (Thermal resistance) of the walls, ceiling, and floor foam per 4.1, as follows:

(c) Calculate the conduction or transmission load through all non-glass components ($Q_{cond\text{-}non\text{-}glass}$), as follows:

$$Q_{cond\text{-}non\text{-}glass} = \sum_1^i \Delta T_i \times \frac{A_{walls,i}}{R_{non\text{-}glass,wall,i}} + \sum_1^j \Delta T_j \times \frac{A_{floor,j}}{R_{non\text{-}glass,floor,j}} + \sum_1^k \Delta T_k \times \frac{A_{ceiling,k}}{R_{non\text{-}glass,ceil,k}} + \sum_1^l \Delta T_l \times \frac{A_{non\text{-}glass\ doors,l}}{R_{non\text{-}glass,door,l}} \quad (3\text{-}10)$$

Where:

$R_{non\text{-}glass,wall,\ i}$ = R-value of foam used in wall panels, of type i, h-ft²-°F/Btu;

$R_{non\text{-}glass,floor,\ j}$ = R-value of foam used in floor panels, of type j, h-ft²-°F/Btu;

$R_{non\text{-}glass,ceil,\ k}$ = R-value of foam used in ceiling panels, of type k, h-ft²-°F/Btu;

$R_{non\text{-}glass,door,\ l}$ = R-value of foam used in non-glass doors, of type l, h-ft²-°F/Btu;

$A_{walls,i}$ = area of wall, of thickness and underlying materials of type i;

$A_{floor,j}$ = area of floor, of thickness and underlying materials of type j;

$A_{ceiling,k}$ = area of ceiling, of thickness and underlying materials of type k; and

$A_{non\text{-}glass\ door,l}$ = area of doors, of thickness and underlying materials of type l.

ΔT_i = dry bulb temperature differential between internal and external air, of type i, °F

ΔT_j = dry bulb temperature differential between internal and external air, of type j, °F

ΔT_k = dry bulb temperature differential between internal and external air, of type k, °F

ΔT_l = dry bulb temperature differential between internal and external air, of type l, °F

3.1.4 Total Conduction Load

(a) Calculate total conduction load, Q_{cond}, (Btu/h), as follows:

$$Q_{cond} = Q_{cond\text{-}non\text{-}glass} + Q_{cond\text{-}glass,wall} + Q_{cond\text{-}glass,door} \quad (3\text{-}11)$$

Where:

$Q_{cond\text{-}non\text{-}glass}$ = conduction load through non-glass components of walk-in, Btu/h; and

$Q_{cond\text{-}glass,wall}$ = total conduction load through walk-in glass walls and inset windows, Btu/h.

$Q_{cond\text{-}glass,door}$ = total conduction load through walk-in glass doors, Btu/h.

3.2 Infiltration Heat Gain

3.2.1 Steady State Infiltration Calculations

(a) Convert dry-bulb internal and external air temperatures from °F to Rankine (°R), as follows:

$$T_{DB\text{-}int,R} = T_{DB\text{-}int} + 459.67\ ^{o}F \quad (3\text{-}12)$$

$$T_{DB\text{-}ext,R} = T_{DB\text{-}ext} + 459.67\ ^{o}F \quad (3\text{-}13)$$

Where:

$T_{DB\text{-}int,R}$ = the dry-bulb temperature of internal walk-in air, °R; and

$T_{DB\text{-}ext,R}$ = the average dry-bulb temperature of air surrounding the walk-in, °R.

(b) Calculate the water vapor saturation pressure for the external air and the internal refrigerated air, as follows:

(1) If $T_{DB,R}$ < 491.67 °R (32 °F), using following equation to calculate water vapor saturation pressure (P_{ws} in psia):

$$P_{ws} = \exp\left[\left(\frac{C_1}{T_{DB,R}}\right) + C_2 + \left(C_3 \times T_{DB,R}\right) + \left(C_4 \times T_{DB,R}^{\ 2}\right) + \left(C_5 \times T_{DB,R}^{\ 3}\right) + \left(C_6 \times T_{DB,R}^{\ 4}\right) + \left(C_7 \times \ln\left(T_{DB,R}\right)\right)\right] \quad (3\text{-}14)$$

Where:

$T_{DB,R}$ = dry-bulb temperature in Rankine (for the internal or external air),

C_1 = −1.0214165 E+04,

C_2 = −4.8932428 E+00,

C_3 = −5.3765794 E–03,

C_4 = 1.9202377 E–07,

C_5 = 3.5575832 E–10,

C_6 = −9.0344688 E–14, and

C_7 = 4.1635019 E+00.

(2) If $T_{DB,R}$ > 491.67 °R (32 °F), use the following equation to calculate water vapor saturation pressure (P_{ws} in psia):

$$P_{ws} = \exp\left[\left(\frac{C_8}{T_{DB,R}}\right) + C_9 + \left(C_{10} \times T_{DB,R}\right) + \left(C_{11} \times T_{DB,R}^{\ 2}\right) + \left(C_{12} \times T_{DB,R}^{\ 3}\right) + \left(C_{13} \times \ln\left(T_{DB,R}\right)\right)\right] \quad (3\text{-}15)$$

Where:

$T_{DB,R}$ = dry-bulb temperature (for the internal and external air), °R;

C_8 = −1.0440397 E+04;

C_9 = −1.1294650 E+01;

C_{10} = −2.7022355 E–02;

C_{11} = 1.2890360 E–05;

C_{12} = 2.4780681 E–09; and

C_{13} = 6.5459673 E+00.

(c) Calculate the absolute humidity ratio, ω, as follows:

$$\omega = \left[\frac{0.62198 \times \left(RH \times P_{ws}\right)}{14.696 - \left(RH \times P_{ws}\right)}\right] \quad (3\text{-}16)$$

Where:

RH = relative humidity in decimal format (*e.g.,* 0.40 for 40 percent) (for the internal or external air), and

P_{ws} = water vapor saturation pressure.

(d) Calculate air specific volume, ν, (ft³/lb), as follows:

$$\nu = \lfloor (0.025210942) \times T_{DB,R} \times (1 + (1.6078 \times \omega)) \rfloor \qquad (3\text{-}17)$$

Where:

$T_{DB,R}$ = dry-bulb temperature (for the internal or external air), °R, and

ω = absolute humidity ratio.

(e) Calculate air density, air density (lb/ft³), as follows:

$$\rho = \frac{1}{\nu} \qquad (3\text{-}18)$$

Where:

ν = specific volume of air, ft³/lb.

(f) Calculate the enthalpy for the internal and external air, h, (Btu/lb), as follows:

$$h = (0.240 \times T_{DB,F}) + \lfloor \omega \times (1061 + (0.444 \times T_{DB,F})) \rfloor \qquad (3\text{-}19)$$

Where:

$T_{DB,F}$ = dry-bulb temperature (for the internal or external air), °F; and

ω = absolute humidity ratio.

(g) Measure the steady-state infiltration rate per 4.2., V_{rate}(1/h)

(h) Convert V_{rate} to $\dot{V}$, (ft³/h), as follows:

$$\dot{V} = V_{rate} \times V_{ref\text{-}space} \qquad (3\text{-}20)$$

Where:

$V_{ref\text{-}space}$ = the total enclosed volume of the walk-in, ft³

V_{rate} = the infiltration rate per 4.2, 1/h

(i) Calculate the total infiltration load due to steady-state infiltration, Q_{infilt}, (Btu/h), as follows:

$$Q_{infilt} = (\rho_{ext} \times h_{ext} - \rho_{int} \times h_{int}) \times \dot{V} \qquad (3\text{-}21)$$

Where:

$\dot{V}$ = the infiltration rate measured from 4.2, ft³/h;

ρ_{int} = internal air density, lb/ft³;

ρ_{ext} = external air density, lb/ft³;

h_{int} = internal air enthalpy, Btu/lb; and

h_{ext} = external air enthalpy, Btu/lb.

3.2.2 Door Opening Infiltration Calculations

(a) Calculate the portion of time each doorway is open, D_t, as follows:

$$D_{t,i} = \frac{\lfloor (P \times \theta_p) + (60 \times \theta_o) \rfloor}{[3600 \times \theta_d]} \qquad (3\text{-}22)$$

Where:

i = index for each unique door. A unique door must be of the same geometry, underlying materials, function, and have the same temperature difference across the door

P = number of doorway passages (*i.e.,* number of doors opening events);

θ_p = door open-close time, seconds per opening P;

θ_o = time door stands open, minutes; and

θ_d = daily time period, h.

(1) Number of doorway passages: For display glass doors, P = 72, and all other doors, P= 60

(2) Door open-close time: For display glass doors, θ_p = 8 seconds. For non-glass doors, if an automatic door opener/closer is used, θ_p = 10 seconds and all other doors, θ_p = 15 seconds.

(3) Time door stands open: Display glass doors, θ_o = 0 minutes and all other doors, θ_o = 15 minutes.

(4) Daily time period: All walk-ins, θ_d = 24 hours.

(b) Calculate the density factor, F_m, for each door, as follows:

$$F_{m,i} = \left[\frac{2}{1 + \left(\frac{\rho_{int,i}}{\rho_{ext,i}} \right)^{1/3}} \right]^{3/2} \qquad (3\text{-}23)$$

Where:

i = index for each unique door

$\rho_{int,i}$ = internal air density, of door type i, lb/ft³; and

$\rho_{ext,i}$ = external air density, of door type i, lb/ft³.

(c) Calculate the infiltration load for fully established flow through each door, q_i (Btu/h), as follows:

$$q_i = 795.6 \times A_i \times (h_{ext,i} - h_{int,i}) \times \rho_{int,i} \times \left(1 - \frac{\rho_{ext,i}}{\rho_{int,i}} \right)^{1/2} \times (g \times H_i)^{1/2} \times F_{m,i} \qquad (3\text{-}24)$$

Where:

i = index for each unique door

A_i = doorway area, of door type i, ft²;

$h_{int,i}$ = internal air enthalpy, of door type i, Btu/lb;

$h_{ext,i}$ = external air enthalpy, of door type i, Btu/lb;

$\rho_{int,i}$ = internal air density, of door type i, lb/ft³;

$\rho_{ext,i}$ = external air density, of door type i, lb/ft³;

H_i = doorway height, of door type i, ft;

$F_{m,i}$ = density factor, of door type i, and

g = acceleration of gravity, 32.174 ft/s².

(d) Calculate the doorway infiltration reduction device effectiveness, E (%), at the same test conditions as described in steady-state infiltration section, as follows:

(1) A sample set must be taken once the tracer gas has uniformly dispersed in the internal space using the methodology described in 4.2.

(2) The test should be repeated exactly as described with the infiltration reduction device removed or deactivated.

(3) Calculate the infiltration reduction effectiveness:

$$E = \frac{V_{rate,with\text{-}device}}{V_{rate,without\text{-}device}} \qquad (3\text{-}25)$$

Where:

$V_{rate,with\text{-}device}$ = air infiltration rate, with door open and reduction device active, using 4.2, 1/h;

$V_{rate,without\text{-}device}$ = air infiltration rate, with door open and reduction device disabled or removed, using 4.2, 1/h.

(e) Calculate the total door opening infiltration load for a single door, Q_{open}, (Btu/h), as follows:

$$Q_{open,i} = q_i \times D_{t,i} \times D_f \times (1 - E_i) \times n_i \qquad (3\text{-}26)$$

Where:

q = infiltration load for fully established flow, Btu/h;
D_t = doorway open-time factor;
D_f = doorway flow factor, 0.8 for freezers and coolers (from ASHRAE Fundamentals);
E = effectiveness of doorway protective device, as measured by gas tracer test, %; and
n_i = number of doors (of the type i being considered in calculation).

(f) Calculate the total load due to door opening infiltration for all doors, Q_{open}, (Btu/h), as follows:

$$Q_{open} = \sum_{1}^{i} Q_{open,i} \qquad (3\text{-}27)$$

3.3 Energy Consumption Due To Total Heat Gain

(a) Calculate the total thermal load, Q_{tot}, (Btu/h), as follows:

$$Q_{tot} = Q_{infilt} + Q_{open} + Q_{cond} \qquad (3\text{-}28)$$

Where:

Q_{infilt} = total load due to steady-state infiltration, Btu/h;
Q_{cond} = total load due to conduction, Btu/h; and
Q_{open}= total load due to door opening infiltration, Btu/h.

(b) Select Energy Efficiency Ratio (EER), as follows:

(1) For coolers, use EER = 12.4 Btu/Wh
(2) For freezers, use EER = 6.3 Btu/Wh

(c) Calculate the total daily energy consumption due to thermal load, $Q_{tot,EER}$, (kWh/day), as follows:

$$Q_{tot,EER} = \frac{Q_{tot}}{EER} \times \frac{24}{1000} \times \frac{kW}{W} \times \frac{h}{day} \qquad (3\text{-}29)$$

Where:

Q_{tot} = total thermal load, Btu/h; and
EER = EER of walk-in (cooler or freezer), Btu/Wh.

3.4 Energy Consumption Related To Electrical Components. Electrical components contained within a walk-in could include, but are not limited to: heater wire (for anti-sweat or anti-freeze application); lights (including display door lighting systems); control system units; and sensors.

3.4.1 Direct Energy Consumption of Electrical Components

(a) Select the required value for percent time off for each type of electricity consuming device, PTO_t (%)

(1) For lights without timers, control system or other demand-based control, PTO = 25 percent. For lighting with timers, control system or other demand-based control, PTO = 50 percent.

(2) For anti-sweat heaters on coolers (if required): Without timers, control system or other demand-based control, PTO = 0 percent. With timers, control system or other demand-based control, PTO = 75 percent. For anti-sweat heaters on freezers (if required): Without timers, control system or other auto-shut-off systems, PTO = 0 percent. With timers, control system or other demand-based control, PTO = 50 percent

(3) For active infiltration reduction devices: Without control by door open or closed position, PTO = 25 percent. With control by door open or closed position for display doors, PTO = 99.33 percent. With control by door open or closed position for other doors, PTO = 99.17 percent.

(4) For all other electricity consuming devices: Without timers, control system, or other auto-shut-off systems, PTO = 0 percent. If it can be demonstrated that the device is controlled by preinstalled timers, control system or other auto-shut-off systems, PTO = 25 percent.

(b) Calculate the power usage for each type of electricity consuming device, $P_{comp,t}$, (kWh), as follows:

$$P_{comp,t} = P_{rated,t} \times (1 - PTO_t) \times n_t \times 24 \qquad (3\text{-}30)$$

Where:

t = index for each type of electricity consuming device with identical rated power;
$P_{rated,t}$ = rated power of each component, of type t, kW;
PTO_t = percent time off, for device of type t, %; and
n_t = number of devices at the rated power of type t.

(c) Calculate the total electrical energy consumption, P_{tot}, (kWh), as follows:

$$P_{tot,int} = \sum_{1}^{t} P_{comp,int,t} \qquad (3\text{-}31)$$

$$P_{tot,ext} = \sum_{1}^{t} P_{comp,ext,t} \qquad (3\text{-}32)$$

Where:

t = index for each type of electricity consuming device with identical rated power;
$P_{comp,int,\ t}$ = the energy usage for an electricity consuming device sited inside the walk-in envelope, of type t, kWh.
$P_{comp,ext,\ t}$ = the energy usage for an electricity consuming device sited outside the walk-in envelope, of type t, kWh.

3.4.2 Total Indirect Electricity Consumption Due to Electrical Devices

(a) Calculate the additional compressor load due to thermal output from electrical components contained within the envelope, C_{load}, (kWh), as follows:

$$C_{load} = P_{tot,int} \times \frac{3.412}{EER} \frac{\text{Btu}}{\text{Wh}} \qquad (3\text{-}33)$$

Where:

EER = EER of walk-in (cooler=12.4 or freezer=6.3), Btu/Wh;
$P_{tot,int}$ = The total electrical load due to components sited inside the walk-in envelope.

3.5 Total Normalized Energy Consumption

3.5.1 Total Energy Load

(a) Calculate the total energy load of the walk-in envelope per unit of surface area, E_{tot} (kWh/ft^2), as follows:

$$E_{tot,non\text{-}glass} = \frac{A_{non\text{-}glass,tot}}{A_{non\text{-}glass,tot} + A_{glass,tot}} \times \left[\frac{Q_{tot,EER}}{A_{non\text{-}glass,tot} + A_{glass,tot}} \right] \qquad (3\text{-}34)$$

$$E_{tot,glass} = \frac{A_{glass,tot}}{A_{non\text{-}glass,tot} + A_{glass,tot}} \times \left[\frac{Q_{tot,EER}}{A_{non\text{-}glass,tot} + A_{glass,tot}} \right] \quad (3\text{-}35)$$

$$E_{tot,electric\text{-}device} = \frac{P_{tot} + C_{load}}{A_{non\text{-}glass,tot} + A_{glass,tot}} \quad (3\text{-}36)$$

Where:

$Q_{tot,EER}$ = the total thermal load, kWh;
P_{tot} = the total electrical load, kWh;
$A_{non\text{-}glass,tot}$ = total surface area of the non-glass envelope, ft^2;
$A_{glass,tot}$ = total surface area glass envelope, ft^2.
C_{load} = additional compressor load due to thermal output from electrical components contained within the envelope, kWh.

4.0 Test Methods and Measurements

4.1 R-Value Testing and Measurements

4.1.1 Measuring R-Value of Insulating Foam

(a) Follow the test procedure in ASTM C1303–08 exactly, except for these exceptions, (incorporated by reference, see § 431.303):

(1) Section 6.6.2, where several types of hot plate methods are recommended, ASTM C518–04, (incorporated by reference, see § 431.303), must be used for measuring the R-value

(2) Section 6.6.2.1, in reference to ASTM C518–04, the mean test temperature of the foam during R-value measurement must be:

(i) For freezers: − 6.7 ± 2 °C (20 ± 4 °F) with a temperature difference of 22 ± 2 °C (40 ± 4 °F)

(ii) For coolers: 12.8 ± 2 °C (55 ± 4 °F) with a temperature difference of 22 ± 2 °C (40 ± 4 °F)

(b) At least one sample set must be prepared, comprised of three stacks, while adhering to all preparation methods and uniformity specifications described in ASTM C1303–08, (incorporated by reference, see § 431.303).

(c) The value resulting LTTR for the foam shall be reported as R_{foam}, but for the purposes of calculations in this test procedure calculations, it will be converted to $R_{non\text{-}glass}$, as follows:

$$R_{non\text{-}glass} = R_{foam} \quad (4\text{-}1)$$

Where:

R_{foam} = R-value of foam as measured by ASTM C1303–08, h-ft^2 – °F/Btu-in.

4.1.2 Determining R-Value of Concrete Floors

(a) For walk-ins in which the floor is concrete instead of insulated panels and has not been supplied by the walk-in manufacturer:

(1) Coolers: Use an R-value of 0.6 for floors of walk-in coolers.

(2) Freezers: Use an R-value of 28 for floors of walk-in freezers.

4.2 Steady State Infiltration Testing

(a) Follow the test procedure in ASTM E741–06 exactly, except for these changes and exceptions to the procedure, (incorporated by reference, see § 431.303):

(1) *Concentration decay method:* The "concentration decay method" must be used instead of other available options described in ASTM E741–06.

(2) *Gas Tracer:* CO_2 must be used as the gas tracer for all testing.

(3) *Air change rate:* Measure the air change rate in ft^3/h, rather than the air change flow described in ASTM E741–06, (incorporated by reference, see § 431.303).

(4) *Spatial measurements:* Spatial measurements must be taken in a minimum of six locations or one location/20 ft^2 of floor area (whichever results in a greater number of measurements) at a height of 3 ft ± 0.5 ft, at a minimum distance of 2 ft ± 0.5 ft from the walk-in walls or doors.

(b) The internal air temperature for freezers and for coolers shall be ± 2 °C (4 °F) of the values shown in Table A.1.

(c) The external air temperature must be 24 °C (75 °F) ± 2.5 °C (5 °F) surrounding the walk-in.

(d) The test must be completed with all reach or walk-in doors closed.

(e) For testing the effectiveness ASTM E741–06 will be used, with the following changes or exceptions to the procedure:

(1) Within 3 minutes ± 30 seconds, with the infiltration reduction device in place, a hinged door should be opened at an angle greater than or equal to 90 degrees. The elapsed time, from zero degrees position (closed) to greater than or equal to 90 degrees (open) must be no longer than 5 seconds. The door must then be held at an angle greater than or equal to 90 degrees for 5 min ±5 seconds and then closed over a period no longer than 5 seconds. For non-hinged doors, the door must reach its maximum opened position, be held open, and reach a fully closed position for the same elapsed time as described above for hinge-type doors.

(2) The gas concentration must be sampled again after the door has been closed. Samples should continue being taken until the gas concentration is once again uniform within the walk-in.

5.0 Calculation of Daily Energy Consumption Coefficients (DECC)

The calculation procedures described in this section are based on the test measurements and other performance parameters discussed and described in the previous sections. The Daily Energy Consumption Coefficients are each combined to provide a linear expression of the daily energy consumption of any walk-in system with the construction features or component design parameters of a tested walk-in design with similar components and features. The DECC figures established using measurements on the test unit may be used to derive the daily electrical energy consumption of other walk-in systems in the same class constructed with similar components of construction as follows:

$$\begin{aligned} E_{tot,system} = {} & DECC_{non\text{-}glass} \times A_{non\text{-}glass,tot} + DECC_{glass} \times A_{glass,tot} + DECC_{infilt,disp\_dr\_opn} \times \\ & A_{disp\_doors} + DECC_{disp\_dr\_device} \times n_{disp\_doors} + DECC_{infilt,non\text{-}display,dr\_opn} \times A_{non\text{-}display\text{-}doors} + \\ & DECC_{non\text{-}display\text{-}dr\_device} \times n_{non\text{-}display\text{-}doors} + DECC_{light} \times V_{ref\_space} + DECC_{ASH} \times A_{disp\_doors} + \\ & DECC_{stir\_fan} \times V_{ref\_space} + DECC_{other} \times V_{ref\_space} \end{aligned} \quad \text{Eq. 5-1}$$

Where:

$DECC_{non\text{-}glass}$ = DECC for non-glass,
$A_{non\text{-}glass,tot}$ = total non-glass surface area,
$DECC_{glass,door}$ = DECC for glass doors,
$A_{glass,glass,\ tot}$ = total glass surface area, and
$DECC_{glass,wall}$ = DECC for glass walls and inset windows,
$A_{glass,wall,\ tot}$ = total glass wall and inset window surface area, and
$DECC_{infilt,disp\_dr\_opn}$ = DECC for opening of display type doors,
A_{disp_doors} = total area of display doors,
$DECC_{disp\_dr\_device}$ = DECC for infiltration reduction device in place for display doors,
n_{disp_doors} = total number of display doors,
$DECC_{infilt,non\text{-}display\_,dr\_opn}$ = DECC for non-display type doors,

$A_{non\text{-}display\_doors}$ = total area of non-display type doors,

$DECC_{non\text{-}display\_dr\_device}$ = DECC for infiltration reduction device in place for non-display doors,

$n_{non\text{-}display\_doors}$ = total number of non-display doors,

$DECC_{light}$ = DECC for lights,

V_{ref_space} = total enclosed refrigerated volume (ft^3),

$DECC_{ASH}$ = DECC for anti-sweat heaters,

$DECC_{stir\_fan}$ = DECC for motors used to drive air mixing fans, and

$DECC_{other}$ = DECC for other electricity consuming devices.

(a) Calculate $DECC_{non\text{-}glass}$ as follows:

$$Q_{tot,non\text{-}glass} = Q_{cond,non\text{-}glass} + Q_{infilt} \times \frac{A_{non\text{-}glass,tot}}{A_{non\text{-}glass,tot} + A_{glass,tot} + A_{glass,wall,tot}} \quad (5\text{-}2)$$

$$E_{thermal,non\text{-}glass} = \frac{Q_{tot,non\text{-}glass}}{EER} \times \frac{24}{1000} \times \frac{h}{day} \times \frac{kW}{W} \quad (5\text{-}3)$$

$$DECC_{non\text{-}glass} = \frac{E_{thermal,non\text{-}glass}}{A_{non\text{-}glass,tot}} \quad (5\text{-}4)$$

Where:

$Q_{cond,non\text{-}glass}$ = conduction load due to non-glass surface area,

$Q_{cond,glass,wall}$ = conduction load due to glass wall and inset window surface area,

$Q_{cond,glass,door}$ = conduction load due to glass door surface area,

Q_{infilt} = load due to steady-state infiltration,

$A_{non\text{-}glass,tot}$ = total non-glass surface area,

$A_{glass,wall,tot}$ = total glass wall and inset window surface area,

$A_{glass,door,tot}$ = total glass door surface area,

EER = energy efficiency ratio for freezer or cooler, as described 3.3(b)

(b) Calculate $DECC_{glass,door}$ as follows:

$$Q_{tot,glass,door} = Q_{cond,glass,door} + Q_{infilt} \times \frac{A_{glass,door,tot}}{A_{non\text{-}glass,tot} + A_{glass,door,tot} + A_{glass,wall,tot}} \quad (5\text{-}5)$$

$$E_{thermal,glass,door} = \frac{Q_{tot,glass,door}}{EER} \times \frac{24}{1000} \times \frac{h}{day} \times \frac{kW}{W} \quad (5\text{-}6)$$

$$DECC_{glass,door} = \frac{E_{thermal,glass,door}}{A_{glass,door,tot}} \quad (5\text{-}7)$$

Where:

$Q_{cond,non\text{-}glass}$ = conduction load due to non-glass surface area,

$Q_{cond,glass,wall}$ = conduction load due to glass wall and inset window surface area,

$Q_{cond,glass,door}$ = conduction load due to glass door surface area,

Q_{infilt} = load due to steady-state infiltration,

$A_{non\text{-}glass,tot}$ = total non-glass surface area,

$A_{glass,wall,tot}$ = total glass wall and inset window surface area,

$A_{glass,door,tot}$ = total glass door surface area,

EER = energy efficiency ratio for freezer or cooler, as described 3.3(b)

(c) Calculate $DECC_{glass,wall}$ as follows:

$$Q_{tot,glass,wall} = Q_{cond,glass,wall} + Q_{infilt} \times \frac{A_{glass,wall,tot}}{A_{non\text{-}glass,tot} + A_{glass,door,tot} + A_{glass,wall,tot}} \quad (5\text{-}8)$$

$$E_{thermal,glass,wall} = \frac{Q_{tot,glass,wall}}{EER} \times \frac{24}{1000} \times \frac{h}{day} \times \frac{kW}{W} \quad (5\text{-}9)$$

$$DECC_{glass,wall} = \frac{E_{thermal,glass}}{A_{glass,wall,tot}} \quad (5\text{-}10)$$

Where:

$Q_{cond,non\text{-}glass}$ = conduction load due to non-glass surface area,

$Q_{cond,glass,wall}$ = conduction load due to glass wall and inset window surface area,

$Q_{cond,glass,door}$ = conduction load due to glass door surface area,

Q_{infilt} = load due to steady-state infiltration,

$A_{non\text{-}glass,tot}$ = total non-glass surface area,

$A_{glass,wall,tot}$ = total glass wall and inset window surface area,

$A_{glass,door,tot}$ = total glass door surface area,

EER = energy efficiency ratio for freezer or cooler, as described 3.3(b)

(d) Compute $DECC_{glass}$ in an identical manner to $DECC_{glass,door}$, described above.

(e) Compute $DECC_{infilt,disp\_dr\_opn}$ and $DECC_{disp\_dr\_device}$ as follows:

$$E_{infilt,disp\_dr\_opn} = \frac{Q_{open,disp\_dr}}{EER} \times \frac{24hr}{1000} \qquad (5\text{-}11)$$

$$DECC_{infilt,disp\_dr\_opn} = \frac{E_{inf\ ilt,disp\_dr\_opn}}{A_{display\_dr}} \qquad (5\text{-}12)$$

Where:

$Q_{open,disp\_dr}$ = total infiltration load calculated for display door-opening events, and

EER = energy efficiency ratio for freezer or cooler

(f) Determine $DECC_{disp\_dr\_device}$ as follows:

(1) For passive infiltration reduction devices (*e.g.,* strip curtains), the $DECC_{disp\_dr\_device}$ is zero.

(2) For active infiltration reduction devices (*e.g.,* air curtains), $DECC_{disp\_dr\_device} = P_{comp}$ where P_{comp} is determined as in section 3.4.1 using the appropriate PTO (percent time off)

(g) Compute $DECC_{infilt,\ non\text{-}display\_dr\_opn}$ and $DECC_{non\text{-}display\_dr\_device}$ in the same manner as $DECC_{infilt,\ disp\_dr\_opn}$ and $DECC_{disp\_dr\_device}$ above.

(h) Compute $DECC_{ASH}$ in the following manner:

$$DECC_{ASH} = \frac{P_{comp,ASH}}{A_{disp\text{-}door}} \qquad (5\text{-}13)$$

Where:

$P_{comp,ASH}$ = total energy consumed by anti-sweat heaters (per section 3.4.1), and

$A_{disp\text{-}door}$ = total surface area of display doors.

(i) Compute $DECC_{stir\_fan}$, for stirring (non-evaporator) fans in the following manner:

$$DECC_{stir\_fan} = \frac{P_{comp,stir\_fan}}{V_{ref\text{-}space}} \qquad (5\text{-}14)$$

Where:

V_{ref_space} = total volume of the refrigerated space (ft^3), and

$P_{comp,stirring\_fan}$ = total energy consumed by stir fan(s) (per 3.4.1).

(j) Compute $DECC_{other}$ for all other electricity consuming devices: For all lights and other electrical loads, $P_{comp,j}$ is determined per the provisions of the section 3.4.1 and the $DECC_{other}$ is obtained by dividing the respective $P_{comp,j}$ by V_{ref_spac}.

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