Dated at Rockville, Maryland, this 2nd day of December, 2003.

For the Nuclear Regulatory Commission.

Annette Vietti-Cook,

Secretary of the Commission.

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. NM270; Notice No. 25–03–08–SC]

Special Conditions: Boeing Model 747–100/200B/200F/200C/SR/SP/100B SUD/400/400D/400F Airplanes; Flammability Reduction System (Fuel Tank Inerting)

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed special conditions.

SUMMARY: This notice proposes special conditions for the Boeing Model 747–100/200B/200F/200C/SR/SP/100B SUD/400/400D/400F series airplanes. These airplanes, as modified by Boeing Commercial Airplanes, will incorporate a new flammability reduction system that uses a nitrogen generation system to reduce the oxygen content in the center wing fuel tank so that exposure to a combustible mixture of fuel and air is substantially minimized. This system is intended to reduce the average flammability exposure of the fleet of airplanes with the system installed to a level equivalent to 3 percent of the airplane operating time. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for the design and installation of this system. These proposed special conditions contain the additional safety standards that the Administrator considers necessary to ensure an acceptable level of safety for the installation of the system and to define performance objectives that the system must achieve to be considered an acceptable means for minimizing the development of flammable vapors in the fuel tank installation.

DATES: Comments must be received on or before January 23, 2004.

ADDRESSES: Comments on this proposal may be mailed in duplicate to: Federal Aviation Administration, Transport Airplane Directorate, Attn: Rules Docket (ANM–113), Docket No. NM270, 1601 Lind Avenue SW., Renton, Washington, 98055–4056; or delivered in duplicate to the Transport Airplane Directorate at the above address. Comments must be marked: Docket No. NM270. Comments may be inspected in the Rules Docket weekdays, except Federal holidays, between 7:30 a.m. and 4 p.m.

FOR FURTHER INFORMATION CONTACT: Mike Dostert, Propulsion and Mechanical Systems Branch, FAA, ANM–112, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue, SW., Renton, Washington, 98055–4056; telephone (425) 227–2132, facsimile (425) 227–1320, e-mail *mike.dostert@faa.gov.*

SUPPLEMENTARY INFORMATION:

Comments Invited

The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. The most helpful comments reference a specific portion of the proposed special conditions, explain the reason for any recommended change, and include supporting data. We ask that you send us two copies of written comments.

All comments received will be filed in the docket, as well as a report summarizing each substantive public contact with FAA personnel concerning these proposed special conditions. The docket is available for public inspection before and after the comment closing date. If you wish to review the docket in person, go to the address in the **ADDRESSES** section of this preamble between 7:30 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

We will consider all comments we receive on or before the closing date for comments. We will consider comments filed late if it is possible to do so without incurring expense or delay. We may change these proposed special conditions based on the comments we receive.

If you want the FAA to acknowledge receipt of your comments on these proposed special conditions, include with your comments a pre-addressed, stamped postcard on which the docket number appears. We will stamp the date on the postcard and mail it back to you.

Background

Boeing Commercial Airplanes intends to modify Model 747 series airplanes to incorporate a new flammability reduction system that will inert the center fuel tanks with nitrogen-enriched air. Though the provisions of § 25.981, as amended by Amendment 25–102, will apply to this design change, these special conditions are being proposed to address novel design features.

Regulations used as the standard for certification of transport category airplanes prior to Amendment 25–102, effective June 6, 2001, were intended to prevent fuel tank explosions by eliminating possible ignition sources from inside the airplane fuel tanks. Service experience of airplanes certificated to the earlier standards shows that ignition source prevention alone has not been totally effective at preventing accidents. Commercial transport airplane fuel tank safety requirements have remained relatively unchanged throughout the evolution of piston-powered aircraft and later into the jet age. The fundamental premise for precluding fuel tank explosions has involved establishing that the design does not result in a condition that would cause an ignition source within the fuel tank ullage (tank vapor space). A basic assumption in this approach has been that the fuel tank could contain flammable vapors under a wide range of airplane operating conditions even though there were periods of time in which the vapor space would not support combustion.

Fuel Properties

The flammability temperature range of jet engine fuel vapors varies with the type of jet fuel, the ambient pressure in the tank, and the amount of dissolved oxygen that may be present in the tank due to vibration and sloshing of the fuel that occurs within the tank.

At sea level pressures and with no sloshing or vibration present, Jet A fuel, the most common commercial jet fuel in the United States, and Jet A1 used in most portions of the world, have flammability characteristics that tend to make the fuel vapor-air mixture too ''lean'' to ignite at temperatures below approximately 100°F, and too ''rich'' to ignite at temperatures above 175°F. This range of flammability (100°F to 175°F) is reduced to cooler temperatures as the airplane gains altitude due to the corresponding reduction of pressure. For example, at an altitude of 30,000 feet the flammability temperature range is approximately 60°F to 120°F.

The flammability range of Jet B (JP–4), another fuel approved for use on most commercial transport airplanes but not used as a primary fuel, is approximately 15°F to 75°F at sea level, and −20°F to 35°F at 30,000 feet. Because Jet B fuel flammable temperature ranges as a function of pressure altitude are more within normal temperatures at altitudes, airplane fuel tanks are flammable for a much larger portion of the flight.

Most commercial transports are approved for operation at altitudes in the range of 30,000 to 45,000 feet. The FAA has always assumed that airplanes would be operated with flammable fuel vapors in their fuel tank ullage. Commercial transports operated in the United States, and in most overseas locales, use Jet A or Jet A–1 fuel, which typically limits exposure to operation in the flammability range to warmer days.

Fire Triangle

Three conditions must be present in a fuel tank to support combustion. These include the presence of a suitable amount of fuel vapor, the presence of sufficient oxygen, and the presence of an ignition source. This has been named the fire triangle. Each point of the triangle represents one of these conditions. Because of technological limitations in the past, the FAA philosophy regarding the prevention of fuel tank explosions to ensure airplane safety was to only preclude ignition sources within fuel tanks. This philosophy included application of fail-safe design requirements to fuel tank components (lightning design requirements, fuel tank wiring, fuel tank temperature limits, etc.) that are intended to preclude ignition sources from being present in fuel tanks even when component failures occur.

Need To Address Flammability

Three accidents have occurred in the last 13 years as the result of unknown ignition sources within the fuel tank in spite of past efforts, highlighting the difficulty in continuously preventing ignition from occurring within fuel tanks. In 1996 the National Transportation Safety Board (NTSB) issued recommendations to improve fuel tank safety that included prevention of ignition sources and addressing fuel tank flammability, *i.e.,* the other two points of the fire triangle.

The FAA initiated safety reviews of all larger transport airplane type certificates to review the fail-safe features of previously approved designs and also initiated research into the feasibility of amending the regulations to address fuel tank flammability. Results from the safety reviews indicated a significant number of single and combinations of failures that can result in ignition sources within the fuel tanks. The FAA has adopted rulemaking to require design and/or maintenance actions to address these issues; however, past experience indicates unforeseen design and maintenance errors can result in development of ignition sources. These findings show minimizing or preventing the formation of flammable vapors by addressing the flammability points of the fire triangle will enhance fuel tank safety. On April 3, 1997, the FAA published a notice in the **Federal Register** (62 FR 16014) that requested comments concerning the 1996 NTSB recommendations regarding reduced flammability. That notice provided significant discussion of the service history, background, and issues related to reducing flammability in transport airplane fuel tanks. Comments submitted to that notice indicated additional information was needed before the FAA could initiate rulemaking action to address all of the recommendations.

Past safety initiatives by the FAA and industry to reduce the likelihood of fuel tank explosions resulting from post crash ground fires have evaluated means to address other factors of the fire triangle. Previous attempts were made to develop commercially viable systems or features that would reduce or eliminate other aspects of the fire triangle (fuel or oxygen) such as fuel tank inerting or ullage space vapor ''scrubbing'' (ventilating the tank ullage with air to remove fuel vapor to prevent the accumulation of flammable concentrations of fuel vapor). Those initial attempts proved to be impractical for commercial transport airplanes due to the weight, complexity, and poor reliability of the systems, or undesirable secondary effects such as unacceptable atmospheric pollution.

Fuel Tank Harmonization Working Group

On January 23, 1998, the FAA published a notice in the **Federal Register** that established an Aviation Rulemaking Advisory Committee (ARAC) working group, the Fuel Tank Harmonization Working Group (FTHWG). The FAA tasked the FTHWG with providing a report to the FAA recommending regulatory text to address limiting fuel tank flammability in both new type certificates and the fleet of in service airplanes. The ARAC consists of interested parties, including the public, and provides a public process to advise the FAA concerning development of new regulations. [**Note:** The FAA formally established ARAC in 1991 (56 FR 2190, January 22, 1991), to provide advice and recommendations concerning the full range of the FAA's safety-related rulemaking activity.]

The FTHWG evaluated numerous possible means of reducing or eliminating hazards associated with explosive vapors in fuel tanks. On July 23, 1998, the ARAC submitted its report to the FAA. The full report is in the docket created for this ARAC working group (Docket No. FAA–1998–4183). This docket can be reviewed on the U.S. Department of Transportation electronic Document Management System on the Internet at *http://dms.dot.gov.*

The report provided a recommendation for the FAA to initiate rulemaking action to amend § 25.981, applicable to new type design airplanes, to include a requirement to limit the time transport airplane fuel tanks could operate with flammable vapors in the vapor space of the tank. The recommended regulatory text proposed, ''Limiting the development of flammable conditions in the fuel tanks, based on the intended fuel types, to less than 7 percent of the expected fleet operational time, or providing means to mitigate the effects of an ignition of fuel vapors within the fuel tanks such that any damage caused by an ignition will not prevent continued safe flight and landing.'' The report included a discussion of various options for showing compliance with this proposal, including managing heat input to the fuel tanks, installation of inerting systems or polyurethane fire suppressing foam, and suppressing an explosion if one occurred.

The level of flammability defined in the proposal was established based on a comparison of the safety record of center wing fuel tanks that, in certain airplanes, are heated by equipment located under the tank, and unheated fuel tanks located in the wing. The ARAC concluded that the safety record of fuel tanks located in the wings with a flammability exposure of 2 to 4 percent of the operational time was adequate and that if the same level could be achieved in center wing fuel tanks, the overall safety objective would be achieved. The thermal analyses documented in the report revealed that center wing fuel tanks that are heated by air conditioning equipment located beneath them contain flammable vapors, on a fleet average basis, in the range of 15 to 30 percent of the fleet operating time.

During the ARAC review, it was also determined that certain airplane types do not locate heat sources adjacent to the fuel tanks and have significant surface areas that allow cooling of the fuel tank by outside air. These airplanes provide significantly reduced flammability exposure, near the 2 to 4 percent value of the wing tanks. The group therefore determined that it would be feasible to design new airplanes such that fuel tank operation in the flammable range would be limited to nearly that of the wing fuel tanks. Findings from the ARAC report indicated that the primary method of compliance available at that time with the requirement proposed by the ARAC would likely be to control heat transfer into and out of fuel tanks such that heating of the fuel would not occur. Design features such as locating the air conditioning equipment away from the fuel tanks, providing ventilation of the air conditioning bay to limit heating and to cool fuel tanks, and/or insulating the tanks from heat sources, would be practical means of complying with the regulation proposed by the ARAC.

In addition to its recommendation to revise § 25.981, the ARAC also recommended that the FAA continue to evaluate means for minimizing the development of flammable vapors within the fuel tanks to determine whether other alternatives, such as ground-based inerting of fuel tanks, could be shown to be cost effective.

To address the ARAC recommendations, the FAA continued with research and development activity to determine the feasibility of requiring inerting for both new and existing designs.

FAA Rulemaking Activity

Based in part on the ARAC recommendations to limit the flammability on new type designs, the FAA developed and published Amendment No. 25–102 in the **Federal Register** on May 7, 2001 (66 FR 23085). The amendment includes changes to § 25.981 that require minimization of fuel tank flammability to address both reduction in the time fuel tanks contain flammable vapors, (new § 25.981(c)), and additional changes regarding prevention of ignition sources in fuel tanks. The new § 25.981(c) is based on the FTHWG recommendation to achieve a safety level equivalent to that achieved by the fleet of transports with unheated aluminum wing tanks, between 2 to 4 percent flammability. The FAA stated in the preamble to Amendment 25–102 that the intent of the rule was to—

> * * * require that practical means, such as transferring heat from the fuel tank (*e.g.*, use of ventilation or cooling air), be incorporated into the airplane design if heat sources were placed in or near the fuel tanks that significantly increased the formation of flammable fuel vapors in the tank, or if the tank is located in an area of the airplane where little or no cooling occurs. The intent of the rule is to require that fuel tanks are not heated, and cool at a rate equivalent to that of a wing tank in the transport airplane being evaluated. This may require incorporating design features to reduce flammability, for example cooling and ventilation means or inerting for fuel tanks located in the center wing box, horizontal stabilizer, or auxiliary fuel tanks located in the cargo compartment.

Advisory circulars associated with Amendment 25–102 include AC 25.981–1B, ''Fuel Tank Ignition Source Prevention Guidelines,'' and AC 25.981–2, ''Fuel Tank Flammability Minimization.'' Like all advisory material, these advisory circulars describe an acceptable means, but not the only means, for demonstrating compliance with the regulations.

FAA Research

In addition to the notice published in the **Federal Register** on April 3, 1997, the FAA initiated research to provide a better understanding of the ignition process of commercial aviation fuel vapors and to explore new concepts for reducing or eliminating the presence of flammable fuel air mixtures within fuel tanks.

Fuel Tank Inerting

In the public comments received in response to the 1997 notice there was reference made to hollow fiber membrane technology that had been developed and was in use in other applications, such as the medical community, to separate oxygen from nitrogen in air. Air is made up of about 78 percent nitrogen and 21 percent oxygen, and the hollow fiber membranes act as a molecular sieve, using the size difference between the nitrogen and oxygen molecules to separate the nitrogen-enriched air (NEA) from the oxygen. In airplane applications NEA is produced when pressurized air from the airplane engines is forced through the hollow fibers. The NEA is then directed, at appropriate nitrogen concentrations, into the ullage space of fuel tanks and displaces the normal fuel vapor/air mixture in the tank.

Use of the hollow fiber technology allowed nitrogen to be separated from air which eliminated the need to carry and store the nitrogen in the airplane. Researchers were aware of the earlier system's shortcomings in the areas of weight, reliability, cost, and performance. Recent advances in the technology have resolved those concerns and eliminated the need for storing nitrogen on board the airplane.

Criteria for Inerting

Earlier fuel tank inerting designs produced for military applications were based on defining ''inert'' as a maximum oxygen concentration of 9 percent. This value was established by the military for protection of fuel tanks from battle damage. One major finding from the FAA's research and development efforts was the determination that the 9 percent maximum oxygen concentration level benchmark established to protect military airplanes from high-energy ignition sources encountered in battle was significantly lower than that needed to inert civilian transport airplane fuel tanks from ignition sources resulting from airplane system failures and malfunctions that have much lower energy. This FAA research established a maximum value of 12 percent as being adequate at sea level. The test results are currently available on FAA Web site: *http://www.fire.tc.faa.gov/pdf/tno2-79.pdf* and will be published in FAA Technical Note ''Limiting Oxygen Concentrations Required to Inert Jet Fuel Vapors Existing at Reduced Fuel Tank Pressures,'' report number DOT/FAA/AR–TN02/79. As a result of this research, the quantity of nitrogen-enriched air that is needed to inert commercial airplane fuel tanks was lessened so that an effective flammability reduction system can now be smaller and less complex than was originally assumed. The 12 percent value is based on the limited energy sources associated with an electrical arc that could be generated by airplane system failures on typical transport airplanes and does not include events such as explosives, turbulent flow flame propagation, or hostile fire.

As previously discussed, existing fuel tank system requirements (contained in earlier Civil Air Regulation (CAR) 4b and now in 14 Code of Federal Regulations (CFR) part 25) have focused solely on prevention of ignition sources. The flammability reduction system is intended to add an additional layer of safety by reducing the exposure to flammable vapors in the heated center wing tank, not necessarily eliminating them under all operating conditions. Consequently, ignition prevention measures will still be the principal layer of defense in fuel system safety, now augmented by substantially reducing the time that flammable vapors are present in higher flammability tanks. It is expected that by combining these two approaches, particularly for tanks with high flammability exposures, such as the heated center wing tank or tanks with limited cooling, risks for future fuel tank explosions can be substantially reduced.

Boeing Application for Certification of a Fuel Tank Inerting System

On November 15, 2002, Boeing Commercial Airplanes applied for a change to Type Certificate A20WE to modify Model 747–100/200B/200F/200C/SR/SP/100B/300/100B SUD/400/400D/400F series airplanes to incorporate a new flammability reduction system that inerts the center fuel tanks with nitrogen-enriched air. The Model 747–100/200B/200F/200C/SR/SP/100B/300/100B SUD/400/400D/400F series airplanes, approved under

Type Certificate No. A20WE, are four-engine transport airplanes with a passenger capacity up to 624 depending upon the submodel. These airplanes have an approximate maximum gross weight of 910,000 lbs with an operating range up to 7,700 miles.

Type Certification Basis

Under the provisions of § 21.101, Boeing Commercial Airplanes must show that the Model 747–100/200B/200F/200C/SR/SP/100B/300/100B SUD/400/400D/400F series airplanes, as changed, continue to meet the applicable provisions of the regulations incorporated by reference in Type Certificate No. A20WE, or the applicable regulations in effect on the date of application for the change. The regulations incorporated by reference in the type certificate are commonly referred to as the ''original type certification basis.'' The regulations incorporated by reference in Type Certificate A20WE include 14 CFR part 25, dated February 1, 1965, as amended by Amendments 25–1 through 25–70, except for special conditions and exceptions noted in Type Certificate Data Sheet A20WE.

In addition, if the regulations incorporated by reference do not provide adequate standards with respect to the change, the applicant must comply with certain regulations in effect on the date of application for the change. The FAA has determined that the FRS installation on the Boeing Model 747–100/200B/200F/200C/SR/SP/100B/300/100B SUD/400/400D/400F series airplanes must also be shown to comply with § 25.981 at Amendment 25–102.

If the Administrator finds that the applicable airworthiness regulations (14 CFR part 25) do not contain adequate or appropriate safety standards for the Boeing Model 747–100/200B/200F/200C/SR/SP/100B/300/100B SUD/400/400D/400F series airplanes because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

In addition to the applicable airworthiness regulations and special conditions, the Model 747–100/200B/200F/200C/SR/SP/100B/300/100B SUD/400/400D/400F series airplanes must comply with the fuel vent and exhaust emission requirements of 14 CFR part 34 and the acoustical change requirements of § 21.93(b).

Special conditions, as defined in § 11.19, are issued in accordance with § 11.38 and become part of the type certification basis in accordance with § 21.101.

Special conditions are initially applicable to the model for which they are issued. Should the type certificate for that model be amended later to include any other model that incorporates the same or similar novel or unusual design feature, or should any other model already included on the same type certificate be modified to incorporate the same or similar novel or unusual design feature, the special conditions would also apply to the other model under the provisions of § 21.101.

Novel or Unusual Design Features

Boeing has applied for approval of a flammability reduction system (FRS) to minimize the development of flammable vapors in the center fuel tanks of Model 747–100/200B/200F/200C/SR/SP/100B SUD/400/400D/400F series airplanes. Boeing also plans to seek approval of this system on Boeing Model 737, 757, 767, and 777 airplanes.

Boeing has proposed to voluntarily comply with § 25.981(c), Amendment 25–102, which is normally only applicable to new type designs or type design changes affecting fuel tank flammability. The provisions of § 21.101 require Boeing to also comply with §§ 25.981(a) and (b), Amendment 25–102, for the changed aspects of the airplane by showing that the FRS does not introduce any additional potential sources of ignition into the fuel tanks.

The proposed FRS uses a nitrogen generation system (NGS) that comprises a bleed-air shutoff valve, ozone converter, heat exchanger, air conditioning pack air cooling flow shutoff valve, filter, air separation module, temperature regulating valve controller and sensor, high-flow descent control valve, float valve, and system ducting. The system will be located in the air conditioning pack bay below the center wing fuel tank. Engine bleed air from the existing engine pneumatic bleed source will flow through a control valve into an ozone converter and then through a heat exchanger, where it will be cooled using outside cooling air. The cooled air will flow through a filter into an air separation module (ASM) that will generate nitrogen-enriched air (NEA), which will be supplied to the center fuel tank, and also discharge oxygen-enriched air (OEA). The OEA from the ASM will be mixed with cooling air from the heat exchanger to dilute the oxygen concentration and then exhausted overboard. The FRS will also include modifications to the fuel vent system to minimize dilution of the nitrogen-enriched ullage in the center tank due to cross-venting characteristics of the existing center wing fuel tank vent design. Certain features of the FRS may introduce a hazard to the airplane if not properly addressed.

Boeing originally proposed that the system be operated only during flight and that the center tank would continue to be inert upon landing and remain inert during normal ground procedures. Boeing has more recently stated that the FRS may be operated on the ground.

Boeing has proposed that limited dispatch relief for operation with an inoperative NGS be allowed. Boeing has initially proposed a 10-day master minimum equipment list (MMEL) relief for the system. Boeing originally proposed that there be no cockpit or maintenance indication onboard for the NGS, and that periodic maintenance, using ground service equipment, be performed to verify system operation. More recently Boeing has stated that to meet system reliability and availability objectives, built-in test functions would be included and system status indication of some kind would be provided but the indication would not be provided in the cockpit. The reliability of the system is expected to be designed to achieve a mean time between failure (MTBF) of 5000 hours or better.

Discussion

The FAA policy for establishing the type design approval basis of the proposed FRS design will result in application of §§ 25.981(a) and (b), Amendment 25–102, for the proposed changes to the airplane that might increase the risk of ignition of fuel vapors. Boeing will therefore be required to substantiate that changes introduced by the FRS system will meet the ignition prevention requirements of §§ 25.981(a) and (b), Amendment 25–102 and other applicable regulations.

With respect to compliance with § 25.981(c), AC 25.981–2 provides guidance in addressing minimization of fuel tank flammability within a heated fuel tank, but there are no specific regulations that address the design and installation of an FRS that inerts the fuel tank. Since Amendment 25–102 was adopted, significant advancements in inerting technology have reduced the size and complexity of inerting systems. Developments in inerting technology have made it practical to significantly reduce fuel tank flammability below the levels required within the rule. However, due to factors such as the limited availability of bleed air and electrical power, it is not considered practical at this time to develop systems for retrofit into existing airplane designs that can maintain a non-flammable tank ullage in all fuel tanks or during all operating conditions. The FAA also recognizes that fuel tank flammability reduction systems could be developed that would meet the flammability requirements of § 25.981(c), Amendment 25–102, but may not preclude fuel tanks from routinely being flammable under the specific operating conditions present when recent accidents occurred.

Definition of ''Inert''

The definition of ''inert'' within these proposed special conditions provides that all portions of the tank under evaluation, including the bulk average of individual compartments, are equal to or less than the 12 percent oxygen limit at sea level. This is necessary because fuel tanks that are compartmentalized may encounter localized oxygen concentrations in one or more compartments that exceed the 12 percent value. Currently there is not adequate data available to establish whether exceeding the 12 percent limit in one compartment of a fuel tank could create a hazard. For example, ignition of vapors in one compartment could result in a flame front within the compartment that travels to adjacent compartments and results in an ignition source that exceeds the ignition energy values used to establish the 12 percent limit. Therefore, ignition in other compartments of the tank may be possible. Technical discussions with the applicant indicate the pressure rise in a fuel tank that was at or near the 12 percent oxygen concentration level would likely be well below the value that would rupture a typical transport airplane fuel tank. While this may be possible to show, it is not within the scope of these proposed special conditions. Therefore, the effect of the definition of ''inert'' within these proposed special conditions is that the bulk average of each individual compartment or bay of the tank be evaluated and shown to meet the oxygen concentration limits specified in the definitions section of these proposed special conditions (12 percent or less at sea level) to be considered inert.

Determining Flammability

The methodology for determining fuel tank flammability defined for use in these proposed special conditions is based on that used by ARAC to compare the flammability of unheated aluminum wing fuel tanks to that of tanks that are heated by adjacent equipment. The ARAC evaluated the relative flammability of airplane fuel tanks using a statistical analysis commonly referred to as a ''Monte Carlo'' analysis that considered a number of factors affecting formation of flammable vapors in the fuel tanks. The Monte Carlo analysis calculates values for the parameter of interest by randomly selecting values for each of the uncertain variables from distribution tables. This calculation is conducted over and over to simulate a process where the variables are random within defined distributions. The results of a large number of flights can then be used to approximate the results of the real world exposure of a large fleet of airplanes.

Factors that are considered in the Monte Carlo analysis included in these special conditions include those affecting all airplane models in the transport airplane fleet such as: a statistical distribution of ground, overnight, and cruise air temperatures likely to be experienced worldwide, a statistical distribution of likely fuel types, and properties of those fuels, a definition of the conditions when the tank in question will be considered flammable, and those affecting specific airplane models such as climb and descent profiles, fuel management, heat transfer characteristics of the fuel tanks, statistical distribution of flight lengths (mission durations) expected for the airplane model worldwide, etc. To quantify the fleet exposure, the Monte Carlo analysis approach is applied to a statistically significant number (1,000,000) of flights where each of the factors described above is randomly selected. The flights are then selected to be representative of the fleet using the defined distributions of the three variables. For example, flight one may be a short mission on a cold day with an average flash point fuel, and flight two may be a long mission on an average day with a low flash point fuel, and on and on until 1,000,000 flights have been defined in this manner. For every one of the 1,000,000 flights, the time that the fuel temperature is above the flash point of the fuel is calculated and used as the parameter that established whether the fuel tank is flammable. Averaging the results for all 1,000,000 flights provides an average percentage of the flight time that any particular flight is considered to be flammable. While these special conditions do not require that the analysis be conducted for 1,000,000 flights, the accuracy of the Monte Carlo analysis improves as the number of flights increases. Therefore, to account for this improved accuracy Appendix 2 of the special conditions defines lower flammability limits if the applicant chooses to use fewer than 1,000,000 flights.

The determination of whether the fuel tank is flammable is based on the temperature of the fuel in the tank determined from the tank thermal model, the atmospheric pressure in the fuel tank, and properties of the fuel loaded for a given flight, which is randomly selected from a database consisting of worldwide data. The criteria in the model is based on the assumption that as these variables change, the concentration of vapors in the tank instantaneously stabilizes and that the fuel tank is at a uniform temperature. This model does not include consideration of the time lag for the vapor concentration to reach equilibrium, the condensation of fuel vapors from differences in temperature that occur in the fuel tanks, or the effect of mass loading (times when the fuel tank is at the unusable fuel level and there is insufficient fuel at a given temperature to form flammable vapors).

Definition of Transport Effects

The effects of mass loading and the effects of fuel vaporization and condensation with time and temperature changes, referred to as ''transport effects'' in these proposed special conditions, are excluded from consideration in the Monte Carlo model used for demonstrating compliance with these proposed special conditions. These effects have been excluded because they were not considered in the original ARAC analysis, which was based on a relative measure of flammability. For example, the 3 percent flammability value established by the ARAC as the benchmark for fuel tank safety for wing fuel tanks did not include the effects of cooling of the wing tank surfaces and the associated condensation of vapors from the tank ullage. If this effect had been included in the wing tank flammability calculation, it would have resulted in a significantly lower wing tank flammability benchmark value. The ARAC analysis also did not consider the effects of mass loading which would significantly lower the calculated flammability value for fuel tanks that are routinely emptied, *e.g.*, center wing tanks. The FAA and JAA have determined that using the ARAC methodology provides a suitable basis for determining the adequacy of an FRS system.

Flammability Limit

The FAA, in conjunction with the Joint Airworthiness Authorities (JAA) and Transport Canada, has developed criteria within these proposed special conditions that require overall fuel tank flammability to be limited to 3 percent of the fleet average operating time. This overall average flammability limit consists of times when the system performance cannot maintain an inert tank ullage, primarily during descent when the change in ambient pressures draws air into the fuel tanks and those times when the FRS is inoperative due to failures of the system and dispatch with the system inoperative.

Specific Risk Flammability Limit

These proposed special conditions also include a requirement to limit fuel tank flammability to 3 percent during ground operations, takeoff, and climb phases of flight to address the specific risk associated with operation during warmer day conditions when accidents have occurred. The specific risk requirement is intended to establish minimum system performance levels and therefore the 3 percent flammability limit excludes reliability related contributions, which are addressed in the average flammability assessment. The specific risk requirement may be met by conducting a separate Monte Carlo analysis for each of the specific phases of flight during warmer day conditions defined in the special conditions, without including the times when the FRS is not available because of failures of the system or dispatch with the FRS inoperative.

Inerting System Indications

Fleet average flammability exposure involves several elements, including—

• The time the FRS is working properly and inerts the tank or when the tank is not flammable;

• The time when the FRS is working properly but fails to inert the tank or part of the tank, because of mission variation or other effects;

• The time the FRS is not functioning properly and the operator is unaware of the failure; and

• The time the FRS is not functioning properly and the operator is aware of the failure and is operating the airplane for a limited time under MEL relief.

The applicant may propose that MMEL relief is provided for aircraft operation with the FRS unavailable; however, it is considered a safety system that should be operational to the maximum extent practical. Therefore, these proposed special conditions include reliability and reporting requirements to enhance system reliability so that dispatch of airplanes with the FRS inoperative would be very infrequent. Cockpit indication of the system function that is accessible to the flightcrew is not an explicit requirement, but may be required if the results of the Monte Carlo analysis show the system cannot otherwise meet the flammability and reliability requirements defined in these proposed special conditions. Flight test demonstration and analysis will be required to demonstrate that the performance of the inerting system is effective in inerting the tank during those portions of ground and the flight operations where inerting is needed to meet the flammability requirements of these proposed special conditions.

Various means may be used to ensure system reliability and performance. These may include: system integrity monitoring and indication, redundancy of components, and maintenance actions. A combination of maintenance indication and/or maintenance check procedures will be required to limit exposure to latent failures within the system, or high inherent reliability is needed to assure the system will meet the fuel tank flammability requirements. The inerting system proposed by the applicant does not incorporate redundant features and includes a number of components essential for proper system operation. Past experience has shown inherent reliability of this type of system would be difficult to achieve. Therefore, if system maintenance indication is not provided for features of the system essential for proper system operation, system functional checks will be required for these features. At a minimum, proper function of essential features of the system should be validated once per day by maintenance review of indications or functional checks, possibly prior to the first flight of the day. The determination of a proper interval and procedure will follow completion of the certification testing and demonstration of the system's reliability and performance prior to certification.

Any features or maintenance actions needed to achieve the minimum reliability of the FRS will result in fuel system airworthiness limitations as defined in § 25.981(b). Boeing will be required to include in the instructions for continued airworthiness (ICA) the replacement times, inspection intervals, inspection procedures, and the fuel system limitations required by § 25.981(b). Overall system performance and reliability must achieve a fleet average flammability that meets the requirements of these special conditions. If the system reliability falls to a point where the fleet flammability exposure exceeds these requirements, Boeing will be required to define appropriate corrective actions, to be approved by the FAA, that will bring the exposure back down to the acceptable level.

Boeing has proposed that the FRS be eligible for a 10-day MMEL dispatch interval. The approved interval will be established by the Flight Operations Evaluation Board (FOEB) based on data submitted by the applicant to the FAA. The MMEL dispatch interval is one of the factors affecting system reliability analyses that must be considered early in the design of the FRS, prior to FAA approval of the MMEL. Boeing has requested that the authorities agree to a MMEL inoperative dispatch interval to be used for design of the system. Data presented by Boeing indicates that certain systems on the airplane are routinely repaired prior to the maximum allowable interval. These proposed special conditions require an MMEL dispatch inoperative interval of 60 hours to be used in the analysis as representative of the mean time for which an inoperative condition may occur for the 10-day MMEL maximum interval requested, and that Boeing include actual dispatch inoperative interval data in the quarterly reports required by these special conditions. Boeing may request to use an alternative interval in the reliability analysis. Use of a value less than 60 hours would be a factor considered by the FOEB in establishing the maximum MMEL dispatch limit. The reporting requirement will provide data necessary to validate that the reliability of the FRS achieved in service meets the levels used in the analysis.

Appropriate maintenance and operational limitations with the FRS inoperative may also be required and noted in the MMEL. The MMEL limitations and any operational procedures should be established based on results of the Monte Carlo assessment, including possible effects of the risk associated with portions of the fleet that operate in warmer climates where the fuel tanks are flammable a significant portion of the operational time when not inert. While the system reliability analysis may show that even with an MMEL allowing very long inoperative intervals, it is possible to achieve an overall average fleet exposure equal to or less than that of a typical unheated aluminum wing tank, the intent of the rule is to minimize flammability and the shortest practical MMEL relief interval should be proposed. To ensure limited airplane operation with the system inoperative and to meet the reliability requirements of these proposed special conditions, appropriate level messages that are needed to comply with any dispatch limitations of the MMEL must be provided.

Confined Space Hazard Markings

Introduction of the FRS will result in NEA within the fuel tanks and the possibility of NEA in compartments adjacent to the fuel tanks if leakage from the tank or NEA supply lines were to occur. Lack of oxygen in these areas could be hazardous to maintenance personnel, the passengers, or flightcrew. These proposed special conditions introduce requirements to address this issue.

Affect of FRS on Auxiliary Fuel Tank System Supplemental Type Certificates

Boeing plans to offer a service bulletin that will install the FRS on existing in-service airplanes. Some in-service airplanes have auxiliary fuel tank systems installed that interface with the center wing tank. The Boeing FRS design is intended to provide inerting of the fuel tank volume of the 747 and does not include consideration of the auxiliary tank installations. Installation of the FRS on existing airplanes with auxiliary fuel tank systems may therefore require additional modifications to the auxiliary fuel tank system to prevent development of a condition that may cause the tank to exceed the 12 percent oxygen limit. The FAA will address these issues during development and approval of the service bulletin for the FRS.

Disposal of Oxygen-Enriched Air

The FRS produces both nitrogen-enriched air (NEA) and oxygen-enriched air (OEA). The OEA generated by the FRS could result in a fire hazard if not disposed of properly. The OEA produced in the proposed design is diluted with air from a heat exchanger, which is intended to reduce the OEA concentration to non-hazardous levels. Special requirements are included in these proposed special conditions to address potential leakage of OEA due to failures and safe disposal of the OEA during normal operation.

To ensure that an acceptable level of safety is achieved for the modified airplanes using a system that inerts heated fuel tanks with nitrogen-enriched air, special conditions (per § 21.16) are needed to address the unusual design features of a flammability reduction system. These proposed special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

Applicability

As discussed above, these proposed special conditions are applicable to the Boeing Model 747–100/200B/200F/200C/SR/SP/100B SUD/400/400D/400F series airplanes. Should the type certificate be amended later to include any other model that incorporates the same or similar novel or unusual design feature, or should any other model already included on the same type certificate be modified to incorporate the same or similar novel or unusual design feature, the special conditions would also apply to the other model under the provisions of § 21.101.

Conclusion

This action affects only certain novel or unusual design features on Boeing Model 747–100/200B/200F/200C/SR/SP/100B SUD/400/400D/400F series airplanes. It is not a rule of general applicability and affects only the applicant who applied to the FAA for approval of these features on the airplane.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

The Proposed Special Conditions

Accordingly, the Federal Aviation Administration (FAA) proposes the following special conditions as part of the type certification basis for Boeing Model 747–100/200B/200F/200C/ SR/SP/100B SUD/400/400D/400F series airplanes, modified by Boeing Commercial Airplanes, to include a flammability reduction system (FRS) that uses a nitrogen generation system to inert the center wing tank with nitrogen-enriched air (NEA).

Compliance with these proposed special conditions does not relieve the applicant from compliance with the existing certification requirements.

I. Definitions.

(a) *Flammable.* With respect to a fluid or gas, flammable means susceptible to igniting readily or to exploding (14 CFR part 1, Definitions). A non-flammable ullage is one where the gas mixture is too lean or too rich to burn and/or is inert per the definition below. For the purposes of these special conditions, a fuel tank is considered flammable when the bulk fuel temperature within any compartment of the tank is within the flammable range for the fuel type being used.

(b) *Flash Point.* The flash point of a flammable fluid is defined as the lowest temperature at which the application of a flame to a heated sample causes the vapor to ignite momentarily, or ''flash.'' The test for jet fuel is defined in the ASTM specification, D56, ''Standard Test Method for Flash Point by Tag Close Cup Tester.''

(c) *Ignition Energy.* The minimum amount of energy required to ignite fuel vapors. The inert oxygen concentration levels, described below in the definition for inert, were established using approximately a 0.5 Joule spark.

(d) *Inert.* For the purpose of these special conditions, the tank is considered inert when the bulk oxygen concentration within each compartment of the tank is 12 percent or less at sea level up to 10,000 feet, then linearly increasing from 12 percent at 10,000 feet to 14.5 percent at 40,000 feet.

(e) *Inerting.* A process where a noncombustible gas is introduced into the ullage of a fuel tank so that the ullage becomes inert.

(f) *Monte Carlo Analysis.* An analytical tool that provides a means to assess the degree of flammability exposure time for a fuel tank. See Appendices 1 and 2 of these special conditions for specific requirements for conducting the Monte Carlo analysis.

(g) *Operational Time.* For the purpose of these special conditions, the time from the start of preparing the airplane for flight (that is, starting and connecting the auxiliary or ground power unit to the aircraft electrical system) through securing all power sources following flight termination.

(h) *Ullage, or Ullage Space.* The volume within the tank not occupied by liquid fuel at the time interval under evaluation.

(i) *Hazardous atmosphere:* An atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from a space), injury, or acute illness.

II. System Performance and Reliability

The FRS, for the airplane model under evaluation, must comply with the performance and reliability requirements as follows:

(a) The applicant must submit a Monte Carlo analysis, as defined in Appendices 1 and 2 of these special conditions that—

(1) Demonstrates that the overall fleet flammability exposure of each fuel tank with an FRS installed is equal to or less than 3 percent of operational time; and

(2) Demonstrates that neither the performance (when the FRS is operational) nor reliability (including all periods when the FRS is inoperative) contributions to the 3 percent overall fleet flammability exposure of a tank with an FRS installed are more than 1.8

percent (this will establish appropriate maintenance inspection procedures and intervals as required in paragraph III(a) of these special conditions).

(b) The applicant must submit a Monte Carlo analysis that demonstrates that the FRS, when functional, reduces the overall fleet flammability exposure of each fuel tank with an FRS installed for warm day ground and climb phases to a level equal to or less than 3 percent of operational time in each of these phases for the following conditions—

(1) The analysis must use the subset of 80° F and warmer days from the Monte Carlo analyses done for overall performance; and

(2) The flammability exposure must be calculated by comparing the time during ground and climb phases for which the tank was flammable and not inert, with the total time for the ground and climb phases.

(c) The applicant must provide data from ground testing, and flight testing that—

(1) Validate the inputs to the Monte Carlo analysis needed to meet paragraphs II(a), (b), and (c) of these special conditions; and

(2) Substantiate that the NEA distribution is effective at inerting all portions of the tank where the inerting system is needed to show compliance with these paragraphs.

(d) The applicant must validate that the FRS meets the requirements of paragraphs II(a), (b), and (c) of these special conditions with any combination of engine model, engine thrust rating, fuel type, and relevant pneumatic system configuration approved for the airplane.

(e) Sufficient accessibility for maintenance personnel, or the flightcrew, must be provided to FRS status indications that are necessary to meet the reliability requirements of paragraph II(a) of these special conditions.

(f) The access doors and panels to the fuel tanks (including any tanks that communicate with an inerted tank via a vent system), and to any other enclosed areas that could contain NEA in the event of a system failure, must be permanently stenciled, marked, or placarded as appropriate to warn maintenance crews of the presence of a potentially hazardous atmosphere.

(g) Oxygen-enriched air produced by the nitrogen generation system must not create a hazard during normal operating conditions. It must be established that no single failure or malfunction or probable combination of failures will jeopardize the safe operation of the airplane.

III. Maintenance

(a) Airworthiness Limitations must be identified for all maintenance and/or inspection tasks required to identify failures of components within the FRS that are needed to meet paragraphs II(a), (b), and (c) of these special conditions.

(b) The applicant must provide the maintenance procedures that will be necessary and present a design review that identifies any hazardous aspects to be considered during maintenance of the FRS that will be included in the instructions for continued airworthiness (ICA) or appropriate maintenance documents.

(c) To ensure that the implications of component failures affecting the FRS are adequately assessed on an on-going basis, the applicant must—

(1) Demonstrate effective means to ensure collection of FRS reliability data. The means must provide data affecting FRS availablity, such as component failures, and the FRS inoperative intervals due to dispatch under the MMEL;

(2) Provide a report to the FAA on a quarterly basis for the first five years of service introduction. After that period, continued quarterly reporting may be replaced with other reliability tracking methods found acceptable to the FAA or eliminated if it is established that the reliability of the FRS meets, and will continue to meet, the exposure requirements of paragraphs II(a) and II(b) of these special conditions;

(3) Provide a report to the validating authorities for a period of at least two years following introduction to service; and

(4) Develop service instructions or revise the applicable airplane manual, per a schedule agreed upon by the FAA, to correct any failures of the FRS that occur in service that could increase the fleet flammability exposure of the tank to more than 3 percent.

Appendix 1

Monte Carlo Analysis

(a) A Monte Carlo analysis must be conducted for the fuel tank under evaluation to determine fleet average flammability exposure for the airplane and fuel type under evaluation. An analysis for a fuel tank is defined in Appendix 2 of these special conditions and must be used as the basis for development of the Monte Carlo analysis to satisfy these special conditions. Parameters used in the Monte Carlo analysis must include:

(1) FRS Performance—as defined by system performance.

(2) Cruise Altitude—as defined by airplane performance.

(3) Cruise Ambient Temperature—as defined in Appendix 2 of these special conditions.

(4) Overnight Temperature Drop—as defined in Appendix 2 of these special conditions.

(5) Flash Point—as defined in Appendix 2 of these special conditions.

(6) Fuel Burn—as defined by airplane performance.

(7) Fuel Load—as defined by airplane performance.

(8) Fuel Transfer—as defined by airplane performance.

(9) Fueling—as defined by airplane performance.

(10) Ground Temperature—as defined in Appendix 2 of these special conditions.

(11) Mach Number—as defined by airplane performance.

(12) Mission Distribution—the applicant must either provide their own data with substantiation or use what is defined in Appendix 2 of these special conditions for mission distribution.

(13) Oxygen Evolution—as defined by airplane performance or as defined in Appendix 2 of these special conditions.

(14) Range—as defined by airplane performance.

(15) Tank Thermal Characteristics—as defined by airplane performance.

(16) Descent Profile Distribution—the applicant must either provide its own fleet representative distribution with substantiation or use a fixed 2500 feet per minute descent rate.

(b) The assumptions for the analysis must include—

(1) Predicted system performance;

(2) Vent losses due to crosswind effects and airplane performance;

(3) Periods when the system is operating properly but fails to inert the tank;

(4) Expected system reliability; and

(5) The MMEL/MEL dispatch inoperative period assumed in the reliability analysis, (60 flight hours must be used for a 10-day MMEL dispatch limit unless an alternative period has been approved by the FAA), including action to be taken when dispatching with the FRS inoperative (*Note:* The actual MMEL dispatch inoperative period data must be included in the engineering reporting requirement of paragraph III(c)(1) of these special conditions);

(6) Possible periods of system inoperability due to latent or known failures, including airplane system shut-downs and failures that could cause the FRS to shut down or become inoperative; and

(7) Affects of failures of the FRS that could increase the flammability of the fuel tank.

(c) The variation assumed in the analysis on each of the parameters (as identified under paragraph (a) of this appendix) that affect flammability must be stated and substantiating data must be included.

Appendix 2

I. Monte Carlo Model

The FAA has developed a Monte Carlo model that can be used to calculate fleet average flammability exposure for a fuel tank in an airplane. The program requires the user to enter the airplane performance data specific to the airplane model being evaluated, such as maximum range, cruise mach number, typical step climb altitudes, tank thermal characteristics specified as exponential heating/cooling time constants, and equilibrium temperatures for various fuel tank conditions. Single flights may be studied, or a multi-flight Monte Carlo analysis may be run. This model is intended to provide comparison trends and not absolute numbers. The general methodology for conducting a Monte Carlo model is described in AC 25.981–2.

The FAA has developed a specific model for calculating fleet average flammability exposure using the Monte Carlo methodology. The FAA model, or one with modifications approved by the FAA, must be used as the means of compliance with these special conditions. The accepted model can be downloaded from the Web site *http://qps.airweb.faa.gov/sfar88flamex.* On this Web site, the model is located under the page ''Flam Ex Resources,'' and is titled ''Monte Carlo Model Version 6a.'' The ''6a'' represents Version 6A. Only version 6A or later of this model can be used. The following procedures, input variables, and data tables must be used in the analysis if the applicant develops a unique model to determine fleet average flammability exposure for a specific airplane type.

II. Monte Carlo Variables and Data Tables

Fleet average flammability exposure is the percent of the mission time the fuel ullage is flammable for a fleet of an airplane type operating over the range of actual or expected missions and in a world-wide range of environmental conditions and fuel properties. Variables used to calculate fleet flammability exposure must include atmosphere, mission length (as defined in Special Condition I(g), Definitions, as Operational Time), fuel flash point, thermal characteristics of the fuel tank, overnight temperature drop, and oxygen evolution from the fuel into the ullage. Transport effects, including mass loading, flammability lag time, and condensation of vapors due to cold surfaces, are not to be allowed as parameters in the analysis.

Atmosphere

In order to predict flammability along a given flight, the variation of ground ambient temperatures, cruise ambient temperatures, and a method to compute the transition from ground to cruise and back again must be used. The variation of the ground and cruise temperatures and the flash point of the fuel can be defined by a Gaussian curve, given by the 50 percent value and a ± 1-sigma value.

The ground and cruise temperatures are linked by a set of assumptions on the atmosphere. The temperature versus altitude follows a standard lapse rate from the ground temperature until the cruise temperature is reached. Above this altitude, the temperature is fixed at the cruise temperature. This gives a variation in the tropopause altitude. For cold days, an inversion is applied up to 10,000 feet, and then the standard lapse rate is applied.

The analysis must be able to execute a number of flights, and for each flight a separate random number must be generated for each of the three parameters (*i.e.*, ground ambient temperature, cruise ambient temperature, and fuel flash point) using the Gaussian distribution defined in Table 1. The applicant can verify the output values from the Gaussian distribution using Table 2. Table 2 is based on typical use of Jet A type fuel. If an airplane is approved for use of lower flash point fuels such as JP–4, Russian, and Chinese fuels, and it is expected to be used for more than 1 percent of the fleet operating time, then the Monte Carlo analysis must include fuel property variation acceptable to the FAA for the approved fuels.

TABLE 1.—GAUSSIAN DISTRIBUTION FOR GROUND AMBIENT, CRUISE AMBIENT, AND FLASH POINT

Temperature in Deg F			
Parameter	Ground amb.	Cruise amb.	Flash point (FP)
Mean Temp	59.95	−70	120
neg 1 std dev	20.14	8	8
pos 1 std dev	17.28		

TABLE 2.—VERIFICATION OF TABLE 1

% probability of temps & flash point being below the listed values	Ground amb. Deg F	Cruise amb. Deg F	Flash point Deg F	Ground amb. Deg C	Cruise amb. Deg C	Flash Point (FP) Deg C
1	13.1	−88.6	101.4	−10.5	−67.0	38.5
5	26.8	−83.2	106.8	−2.9	−64.0	41.6
10	34.1	−80.3	109.7	1.2	−62.4	43.2
15	39.1	−78.3	111.7	3.9	−61.3	44.3
20	43.0	−76.7	113.3	6.1	−60.4	45.1
25	46.4	−75.4	114.6	8.0	−59.7	45.9
30	49.4	−74.2	115.8	9.7	−59.0	46.6
35	52.2	−73.1	116.9	11.2	−58.4	47.2
40	54.8	−72.0	118.0	12.7	−57.8	47.8
45	57.4	−71.0	119.0	14.1	−57.2	48.3
50	59.9	−70.0	120.0	15.5	−56.7	48.9
55	62.1	−69.0	121.0	16.7	−56.1	49.4
60	64.3	−68.0	122.0	18.0	−55.5	50.0
65	66.6	−66.9	123.1	19.2	−55.0	50.6
70	69.0	−65.8	124.2	20.6	−54.3	51.2
75	71.6	−64.6	125.4	22.0	−53.7	51.9
80	74.5	−63.3	126.7	23.6	−52.9	52.6
85	77.9	−61.7	128.3	25.5	−52.1	53.5
90	82.1	−59.7	130.3	27.8	−51.0	54.6
95	88.4	−56.8	133.2	31.3	−49.4	56.2
99	100.1	−51.4	138.6	37.9	−46.3	59.2

Flight Mission Distribution

The mission length is determined from an equation that takes the maximum mission length for the airplane and creates multiple flight lengths based on typical airline usage.

The mission length is also used to define the time on the ground prior to takeoff, and the type of flight profile to be followed. Table 3 must be used to define the mission distribution, unless the applicant has more appropriate data for the specific airplane model under evaluation, together with substantiation for the data. A linear interpolation may be used between the table values.

TABLE 3.—MISSION DISTRIBUTION

Airplane Maximum Range—Nautical Miles (NM)

Range (NM)		Distribution of missions (%)									
From	To	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
0	200	11.7	7.5	6.2	5.5	4.7	4.0	3.4	3.0	2.6	2.3
200	400	27.3	19.9	17.0	15.2	13.2	11.4	9.7	8.5	7.5	6.7
400	600	46.3	40.0	35.7	32.6	28.5	24.9	21.2	18.7	16.4	14.8
600	800	10.3	11.6	11.0	10.2	9.1	8.0	6.9	6.1	5.4	4.8
800	1000	4.4	8.5	8.6	8.2	7.4	6.6	5.7	5.0	4.5	4.0
1000	1200	0.0	4.8	5.3	5.3	4.8	4.3	3.8	3.3	3.0	2.7
1200	1400	0.0	3.6	4.4	4.5	4.2	3.8	3.3	3.0	2.7	2.4
1400	1600	0.0	2.2	3.3	3.5	3.3	3.1	2.7	2.4	2.2	2.0
1600	1800	0.0	1.2	2.3	2.6	2.5	2.4	2.1	1.9	1.7	1.6
1800	2000	0.0	0.7	2.2	2.6	2.6	2.5	2.2	2.0	1.8	1.7
2000	2200	0.0	0.0	1.6	2.1	2.2	2.1	1.9	1.7	1.6	1.4
2200	2400	0.0	0.0	1.1	1.6	1.7	1.7	1.6	1.4	1.3	1.2
2400	2600	0.0	0.0	0.7	1.2	1.4	1.4	1.3	1.2	1.1	1.0
2600	2800	0.0	0.0	0.4	0.9	1.0	1.1	1.0	0.9	0.9	0.8
2800	3000	0.0	0.0	0.2	0.6	0.7	0.8	0.7	0.7	0.6	0.6
3000	3200	0.0	0.0	0.0	0.6	0.8	0.8	0.8	0.8	0.7	0.7
3200	3400	0.0	0.0	0.0	0.7	1.1	1.2	1.2	1.1	1.1	1.0
3400	3600	0.0	0.0	0.0	0.7	1.3	1.6	1.6	1.5	1.5	1.4
3600	3800	0.0	0.0	0.0	0.9	2.2	2.7	2.8	2.7	2.6	2.5
3800	4000	0.0	0.0	0.0	0.5	2.0	2.6	2.8	2.8	2.7	2.6
4000	4200	0.0	0.0	0.0	0.0	2.1	3.0	3.2	3.3	3.2	3.1
4200	4400	0.0	0.0	0.0	0.0	1.4	2.2	2.5	2.6	2.6	2.5
4400	4600	0.0	0.0	0.0	0.0	1.0	2.0	2.3	2.5	2.5	2.4
4600	4800	0.0	0.0	0.0	0.0	0.6	1.5	1.8	2.0	2.0	2.0
4800	5000	0.0	0.0	0.0	0.0	0.2	1.0	1.4	1.5	1.6	1.5
5000	5200	0.0	0.0	0.0	0.0	0.0	0.8	1.1	1.3	1.3	1.3
5200	5400	0.0	0.0	0.0	0.0	0.0	0.8	1.2	1.5	1.6	1.6
5400	5600	0.0	0.0	0.0	0.0	0.0	0.9	1.7	2.1	2.2	2.3
5600	5800	0.0	0.0	0.0	0.0	0.0	0.6	1.6	2.2	2.4	2.5
5800	6000	0.0	0.0	0.0	0.0	0.0	0.2	1.8	2.4	2.8	2.9
6000	6200	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.6	3.1	3.3
6200	6400	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.4	2.9	3.1
6400	6600	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.8	2.2	2.5
6600	6800	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	1.6	1.9
6800	7000	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	1.1	1.3
7000	7200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.8
7200	7400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.7
7400	7600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.6
7600	7800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.7
7800	8000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.8
8000	8200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.8
8200	8400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0
8400	8600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.3
8600	8800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1
8800	9000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8
9000	9200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
9200	9400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
9400	9600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9600	9800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9800	10000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

Fuel Tank Thermal Characteristics

The applicant must account for the thermal conditions of the fuel tank both on the ground and in flight. The Monte Carlo model, available on the Web site listed above, defines the ground condition using an equilibrium delta temperature (relative to the ambient temperature) that the tank will reach given a long enough time, with any heat inputs from airplane sources. Values are also input to define two exponential time constants (one for a near empty tank and one for a near full tank) for the ground condition. These time constants define the time for the fuel in the fuel tank to heat or cool in response to heat input. The fuel is assumed to heat or cool according to a normal exponential transition, governed by the temperature difference between the current temperature and the equilibrium temperature, given by ambient temperature plus delta temperature. Input values for this data can be obtained from validated thermal models of the tank based on ground and flight test data. The inputs for the inflight condition are similar but are used for inflight analysis.

Fuel management techniques are unique to each manufacturer's design and variations in fuel load within the tank for given points in the flight must be accounted for in the model. The model uses a ''tank full'' time, specified in minutes, that defines the time before touchdown when the fuel tank is still full. For a center wing tank used first, this number would be the maximum flight time, and the tank would start to empty at takeoff. For a main tank used last, the tank will remain full for a shorter time before touch down, and would be ''empty'' at touch down (i.e., tank empty at 0 minutes before touch down). In the case of a main tank with reserves, the term empty means at reserve level rather than totally empty. The thermal data for tank empty would also be for reserve level.

The model also uses a ''tank empty'' time to define the time when the tank is emptying, and the program uses a linear interpolation between the exponential time constants for full and empty during the time the tank is emptying. For a tank that is only used for long-range flights, the tank would be full only on very long-range missions and would be empty a long time before touch down. For short flights, it would be empty for the whole flight. For a main tank that carried reserve fuel, it would be full for a long time and would only be down to empty at touch down. In this case, empty would really be at reserve level, and the thermal constants at empty should be those for the reserve level.

The applicant, whether using the available model or using another analysis tool, must propose means to validate thermal time constants and equilibrium temperatures to be used in the analysis. The applicant may propose using a more detailed thermal definition, such as changing time constants as a function of fuel load, provided the details and substantiation information are acceptable and the Monte Carlo model program changes are validated.

Overnight Temperature Drop

An overnight temperature drop must be considered in the Monte Carlo analysis as it may affect the oxygen concentration level in the fuel tank. The overnight temperature drop for these special conditions will be defined using:

- A landing temperature that is a random value based on a Gaussian distribution; and
- An overnight temperature drop that is a random value based on a Gaussian distribution.

For any flight that will end with an overnight ground period (one flight per day out of an average of x flights per day, depending on utilization of the particular airplane model being evaluated), the landing outside air temperature (OAT) is to be chosen as a random value from the following Gaussian curve:

TABLE 4.—LANDING OAT

Parameter	Landing temperature °F
Mean Temp	58.68
neg 1 std dev	20.55
pos 1 std dev	13.21

The outside ambient air temperature (OAT) drop for that night is to be chosen as a random value from the following Gaussian curve:

TABLE 5.—OAT DROP

Parameter	OAT drop temperature °F
Mean Temp	12.0
1 std dev	6.0

Oxygen Evolution

Fuel contains dissolved gases, and in the case of oxygen and nitrogen absorbed from the air, the oxygen level in the fuel can exceed 30 percent, instead of the normal 21 percent oxygen in air. Some of these gases will be released from the fuel during the reduction of ambient pressure experienced in the climb and cruise phases of flight. The applicant must consider the effects of air evolution from the fuel on the level of oxygen in the tank ullage during ground and flight operations and address these effects on the overall performance of the FRS. The applicant must provide the air evolution rate for the fuel tank under evaluation, along with substantiation data.

Number of Flights Required in Analysis

In order for the Monte Carlo analysis to be valid for showing compliance with the flammability requirements of these special conditions, the applicant must run the analysis for an appropriate number of flights to ensure that the flammability exposure for the fuel tank under evaluation meets the criteria defined in Table 6.

TABLE 6.—FLAMMABILITY LIMIT

Number of flights in Monte Carlo analysis	Maximum acceptable fuel tank flammability (%)
1,000	2.73
5,000	2.88
10,000	2.91
100,000	2.98
1,000,000	3.00

Issued in Renton, Washington, on November 28, 2003.

Kevin M. Mullin,

Acting Manager, Transport Airplane Directorate, Aircraft Certification Service.

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 71

[Docket No. FAA–2003–16534; Airspace Docket No. 03–ASO–19]

Proposed Establishment of Class D and Class E4 Airspace; Olive Branch, MS Proposed Amendment of Class E5 Airspace; Memphis, TN

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking.

SUMMARY: This notice proposes to establish Class D and Class E4 airspace at Olive Branch, MS, and amend Class E5 airspace at Memphis, TN. A Federal contract tower with a weather reporting system is being constructed at the Olive Branch Airport. Therefore, the airport will meet the criteria for establishment of Class D and Class E4 airspace. Class D surface area airspace and Class E4 airspace designated as an extension to Class D airspace is required when the control tower is open to contain existing Standard Instrument Approach Procedures (SIAPs) and other Instrument Flight Rules (IFR) operations at the airport. This action would establish Class D airspace extending upward from the surface to and including 2,900 feet MSL within a 4-mile radius of the Olive Branch Airport and Class E airspace extensions that are 5 miles wide and extend 7 miles northeast and south of the airport. A regional evaluation has determined the existing Class E5 airspace area for Memphis, TN, which includes the Olive Branch Airport, should be amended to contain the Nondirectional Radio Beacon (NDB) Or Global Positioning System (GPS) Runway (RWY) 18 and RWY 36 SIAPs. As a result, controlled airspace extending upward from 700 feet Above Ground Level (AGL) is needed to contain the procedure turn airspace area.

DATES: Comments must be received on or before January 8, 2004.

ADDRESSES: Send comments on this proposal to the Docket Management System, U.S. Department of Transportation, Room Plaza 401, 400 Seventh Street, SW., Washington, DC 20590–0001. You must identify the docket number FAA–2003–16534/ Airspace Docket No. 03–ASO–19, at the beginning of your comments. You may also submit comments on the Internet at *http://dms.dot.gov*. You may review the public docket containing the proposal, any comments received, and any final disposition in person in the Dockets