

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 (M MEL) 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 inert 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