

UNITED STATES OF AMERICA  
DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION

In the matter of the petition of

**THE BOEING COMPANY**

for an exemption from § 25.1103(b)(2) of  
title 14, Code of Federal Regulations

**Regulatory Docket No. FAA-2020-1141**

**GRANT OF EXEMPTION**

By letter dated November 24, 2020, Grant Lehmann, Chief Engineer, Regulatory Administration and Airworthiness, The Boeing Company (Boeing), petitioned the Federal Aviation Administration (FAA) for an exemption from the requirements of § 25.1103(b)(2), at amendment 25-46, of title 14, Code of Federal Regulations (14 CFR). This exemption provides relief from the requirement that the ducts for the auxiliary power unit (APU) air inlet system (induction system) be fireproof. This exemption is applicable to Model 747-8 airplanes that have been modified as part of the supplemental type certification project ST00483MC-T.

**The petitioner requests relief from the following regulation:**

Section 25.1103(b)(2) prescribes, in pertinent part, that each induction system duct for the auxiliary power unit (APU) must be fireproof within the APU fire zone.

**The petitioner supports their request with the following information:**

This section quotes the relevant information from the petitioner's request with minor edits for clarity. The complete petition is available at the Department of Transportation's Federal Docket Management System, on the Internet at <http://regulations.gov>, in Docket No. FAA-2020-1141.

### **The Extent of Relief Sought and Reason(s)**

Regulation	Requires:	Relief is Necessary because:
14 CFR 25.1103(b)(2), amendment 25-46	14 CFR 25.1103(b)(2) requires each induction system duct to be fire resistant "...except that ducts for auxiliary power units must be fireproof within the auxiliary power unit fire zone."	Boeing 747-8 airplanes as modified by Boeing do not directly comply with the requirements of title 14, Code of Federal Regulations (14 CFR) 25.1103(b)(2) as applicable to portions of the APU air inlet system. Several portions of the 747-8 variant APU inlet are not able to show fireproof capability. The technical impact of design changes required for fireproof capability meeting the current [Advisory Circular] AC 20-135 standards are not commensurate with the safety benefit of the modifications. All other areas of the APU air inlet system will be shown to be directly compliant to the regulation.

### **[Petitioner's] Description of Issue**

In the original version of 14 CFR 25.1103(b)(2), the regulation applied to the auxiliary power unit (APU) air inlet system (induction system) required that the system be fire resistant. At amendment 25-46, this regulation was changed to require the air inlet ducts for the APU to be fireproof.

The application of the regulation is evolving to include required compliance showings for the entirety of the APU air inlet system: airplane inlet ducting and APU engine plenum, including all seals and penetrations, and APU engine interfacing structure.

The inclusion of the APU inlet interfaces with 14 CFR 25.1103(b)(2), amendment 25-46, is a new understanding of compliance requirements relative to all previous compliance showings for APU system installations.

Some previously FAA accepted certification testing does not meet current Advisory Circular (AC) 20-135 standards for fireproof. Boeing is seeking relief from 14 CFR 25.1103(b)(2) as it applies to several portions of the STC modified 747-8 APU inlet air system.

It is important to note that the amount of area represented by the items for which Boeing is seeking relief is small relative to the remainder of the APU inlet system that will be shown to be fireproof. Fireproof portions of the inlet include all airplane APU inlet ducting and APU engine plenum structure, along with all penetrations of the plenum.

The proposed design and use of the modified 747-8 airplanes will be similar to previous VIP, private-use airplanes that are not-for-hire nor common-carriage.

### **Legacy Certified Capability**

The modified 747-8 APU air inlet system is similar in configuration to the 747, 777, and 787 air inlets which are entirely contained within the APU compartment. The aircraft side

APU inlet ducting is constructed with fireproof material. That compliance will be carried over to this airplane.

This airplane's APU interface seal is of same material as the seal used on the 767-200/-300. However, the previously accepted fire test data on the 767-200/-300 seal, and recent development testing on this modified 747-8, indicates unacceptable continued burning and backside ignition. Hence, this item will be part of the exemption for this program.

The modified 747-8 APU air inlet plenum is constructed of the same sheet metal used on the 767 APUs. Previous fire test data from the 767-200/-300 program demonstrated fireproof capability of the APU sheet metal inlet plenum. However, previously approved test data and recent development test data indicate some areas of the APU inlet plenum do not meet current fireproof expectations. All areas of the APU inlet plenum on the modified 747-8 design determined to be vulnerable to APU plenum and/or compartment fires will be demonstrated to be fireproof, except for some areas which did not meet the requirement as a result of the evolving application of the regulation.

#### Modified 747-8 Baseline Capability

Derivative airplanes and APUs using the same or similar parts as used in previous APU air inlet systems would ordinarily rely on previously approved data and analysis based on the assumptions and guidance applicable at the time. However, for this modified 747-8, the level of change, lack of data, current guidance, and development test results lead to a re-evaluation of compliance of the APU air inlet system.

Multiple areas cannot pass the fireproof or fire resistance testing per AC 20-135 criteria. Development fire testing in support of this modified 747-8 airplane confirms the above. To meet fireproof or fire resistance in the proposed exempt locations, design changes would be required; however, the design changes required are not proportional to the added safety benefit of the change.

#### Direct Compliance Challenges

Boeing has evaluated the technical risk associated with modifying the existing design for a fleet of two (2) aircraft to fully meet the fireproof regulation in all locations of the inlet. Design changes for direct compliance are likely to require multiple design iterations due to complexity, adding uncertainty to entry into service. Additional changes are not considered to be practical by Boeing because the technical and economic risks, as well as the potential negative impacts to long-term in-service durability, would not be commensurate with an increased level of safety.

#### **[Petitioner's] Statement of Public Interest**

Approval of this request for exemption from § 25.1103(b)(2) for the Boeing Model 747-8, when modified to install new APU installation, is in the public interest of the people of the United States of America.

- 1) Modifications to existing APU designs to allow for direct compliance showings are technically and economically impractical given the limited increase in the level of safety that would be realized.
- 2) Stability and improved financial performance of these United States companies gives greater job stability to the workers employed by the companies, causing a stabilizing influence to the greater United States economy, due to the consumer pending activities associated with stable workers.
- 3) Improved financial performance of United States owned and operated corporations, and increased workforce stability translates into continued and improved local, state, and federal tax revenues which in turn adds to the stability of the total United States economy.
- 4) Improved financial performance allows United States corporations to continue to invest in Research and Development allowing the United States to maintain or improve its competitive position in the world economy.
- 5) The exemption request, if granted, allows the FAA to expend resources on this subject only this one time, and thereafter to concentrate resources on the FAA's highest priorities.
- 6) Denial of this petition for exemption could result in a delivery delay to the customer who requires these aircraft to replace an aging fleet which is less economically and environmentally desirable to operate. The customer is expected to replace its aging fleet with this variant allowing them a more cost-effective acquisition and operations in support of their travel requirement.

#### **[Petitioner's] Statement of No Adverse Effect on Safety**

In accordance with 14 CFR 25.1103(b)(2), the 747-8 modified by Boeing will be shown compliant to a higher certification basis than the legacy 747-8 for all locations of the APU inlet air system, except those for which Boeing is seeking relief, thereby advancing the level of safety through the introduction of the airplane into service. The location and design of the APU compartment maintains protection of critical components of the flight control system located adjacent to the APU fire zone, in turn providing the capability needed to complete safe flight and landing following an in-flight fire within the APU air inlet or the APU compartment, and fire protection features of the modified 747-8 ensure APU fires are isolated to the APU compartment.

In lieu of implementing a fireproof design for the areas of the requested exemption, enhancements will be made to the inlet overheat detection capability providing comparable function to the APU compartment fire detection system. The intent of these enhancements, in combination with the modified 747-8 APU fire protection features, will assist in minimizing the overall hazards from an APU air inlet fire when compared to legacy installations. The hazard of fire inside the compartment is mitigated successfully

by limiting the fire intensity and exposure in the APU compartment through fire protection features part of the modified 747-8.

In addition, when considering safety critical scenarios, the APU is not an essential source of power in flight. There are 4 engines on this 747-8 variant providing 4 independent sources for pneumatic power, electrical power, with separate hydraulic systems and a Ram Air Turbine (RAT) to be used as required. APU operation can be used in flight as a matter of convenience because APU function is not required for continued safe flight and landing.

The modified 747-8 APU installation will include the following changes as conditions of this exemption to enhance the APU functions mentioned above:

- 1) *Upgrade sensor wiring to qualified fire resistant wire*
- 2) *Modify APUC software to inhibit APU restart following inlet overhear auto shutdown*
- 3) *Modify APUC software to inhibit APU restart and initiate APU auto shutdown for failed sensor*
- 4) *Modify APU controller software to maintain active status of the EICAS alert following inlet overhear detection or failed sensor APU auto shutdown*

In addition to the above, dispatch with the APU inlet door locked open will be removed from the appropriate Boeing dispatch provision document (e.g., Minimum Equipment List) for this modified 747-8. Prohibiting dispatch with the APU inlet door locked open will ensure that the fire protection function of cutting off the air source for an internal inlet fire is enabled. This will help limit inlet fire burn time of the four areas requested in this exemption.

Fireproof portions of the modified 747-8 APU inlet air system represent the majority of the total inlet surface area, compared to the small surface area for which this exemption is requesting. As such, the effect of the exemption on APU fire extinguishing capability is expected to be proportionately small. Through the combination of modified 747-8 fire protection features and the design enhancements described in this exemption, there are no un-annunciated failures of the APU fire protection system and inlet overhear detection. Any fires initiated in the vicinity of the exemption components are expected to be detected automatically through compartment fire detection or inlet overhear detection.

#### *Consequence of Fire at Proposed Exempt Locations*

There are three fire scenarios to consider when evaluating the consequence of fire at the located proposed in this exemption.

- 1) Inlet fire burns through into APU compartment
- 2) APU compartment fire burns into inlet

3) APU compartment fire in both compartments simultaneously

For each of these scenarios, the fire safety assessment will evaluate the effect on the fire protection features outlined above and how these features mitigate the resulting hazards.

Service History

Extensive service records are available for Boeing airplane models with similar Honeywell APU engines and APU compartment configurations, which provide historical evidence of inlet fire safety. Forty years of Boeing commercial aircraft service data was examined totaling over 345 million flight hours from the following Boeing models:

- Similar APU engines: 757-200/-300 and 767-200/-300 (331-200 APU), 767-400ER (331-400[B] APU, 777 (331-500[B] APU)
- Similar configurations with the air inlets entirely contained within the APU compartment: 747, 777, 787

The service history cited above informs the modified 747-8 APU installation design and the expected safety level of the various fire protection features. The rate of occurrence for APU compartment and inlet fires for the modified 747-8 is expected to be comparable to the Boeing commercial fleet. The risk of fire spreading outside the APU compartment to the airplane is expected to remain low even with consideration of the effects of the exempted components of the APU air inlet system. Therefore, the exemption from 14 CFR 25.1103(b)(2) is not expected to adversely affect overall APU fire safety.

**[Petitioner's] Request to 'Waive Publication and Comment'**

Not requested.

**[Petitioner's Request to Exercise] Privileges of the Exemption Outside the United States**

Not requested.

**[Petitioner's] Conclusion**

Based upon the capability of the fire protection features of this aircraft, and enhancements to be implemented as part of the modified 747-8 design, exempting the locations described from demonstrating fireproof capability will not adversely impact the overall safety of this airplane.

Boeing is seeking relief from 14 CFR 25.1103(b)(2) in several areas of the modified 747-8 APU inlet. Boeing will provide design enhancements as conditions of the exemption to be included as a part of the substantiation documentation provided in support of certification.

The conditions of this exemption and the modified 747-8 fire protection features described, provide increased hazard mitigation to ensure the overall level of aircraft safety is unaffected and the APU installation meets the intent of 14 CFR 25.1103(b)(2).

**Federal Register publication:**

A summary of the petition was published in the *Federal Register* on December 8, 2020 (85 FR 79070). The FAA received no comments.

**The FAA's analysis is as follows:**

The FAA's analysis of this petition is based upon the original petition and additional proprietary information received from The Boeing Company on November 24, 2020. The FAA has reviewed the information provided by Boeing and has concluded that granting this exemption is in the public interest for the reasons stated by the applicant and the reasons discussed below.

As mentioned previously, § 25.1103(b)(2), at amendment 25-46, requires, in pertinent part, each induction system duct for the auxiliary power unit (APU) must be fireproof within the APU fire zone. However, not all portions of the APU air inlet system design of the Boeing Model 747-8 modified as part of the supplemental type certification (STC) project (ST00483MC-T) can meet this requirement. The portions of the APU air inlet system design that are not fireproof are the aft barrel seal, forward barrel seal, load compressor inlet housing, and the inlet plenum seal.

In order to show full compliance with § 25.1103(b)(2), at amendment 25-46, Boeing would need to redesign these portions of the APU air inlet system. There are only two Model 747-8 airplanes that will be delivered with these limited areas of the APU air inlet system that are not fireproof. Full compliance would be impractical because it would necessitate design changes that would increase the complexity of the design and have a negative impact to long term in service durability, without a proportional benefit to safety.

Additionally, these modified airplanes will replace aging airplanes that are less economically, technologically, and environmentally desirable to operate. The design changes that are part of this STC project include improving the fire protection capability for sensor wiring and modifications to the APU controller software that will (1) inhibit an APU restart following an APU inlet overheat auto shutdown of the APU, (2) inhibit an APU restart and initiate an APU shutdown if a sensor has failed, and (3) maintain the active status of the engine indicating crew alerting system (EICAS) alert following an APU inlet overheat detection or a failed sensor APU auto shutdown. The Model 747-8 APU engine and air inlet system are contained entirely within the APU fire zone and the APU fire protection features will ensure that APU fires are isolated to the APU compartment. Through the combination of modified fire protection features for the Model 747-8 airplane and the design enhancements described in this exemption, there will be no un-annunciated failures of the APU fire protection system and APU inlet overheat detection system. Any fires that are in the vicinity of the APU air inlet system that are not fireproof are expected to be detected automatically through APU compartment fire detection or APU inlet overheat detection.

Boeing will also modify the dispatch deviation provision document for these STC-modified Model 747-8 airplanes that will prohibit dispatch of the airplanes with the APU inlet door locked open. Prohibiting dispatch with the APU inlet door locked open will ensure that the fire protection function for cutting off the air source for an internal inlet fire is available.

These design changes will result in a safety improvement over the existing design as the fire protection features will help to minimize the hazards from an APU air inlet fire when compared to existing APU air inlet systems. The hazard of a fire inside of the APU compartment is mitigated by limiting the intensity and exposure of a fire that could occur in the APU compartment and prevent the fire from propagating outside of the APU compartment; thereby, maintaining protection of critical components of the flight control system located adjacent to the APU fire zone.

### **The FAA's Decision**

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. §§ 40113 and 44701(f) delegated to me by the Administrator, I grant The Boeing Company an exemption from 14 CFR § 25.1103(b)(2), at amendment 25-46, as it relates to particular areas of the APU air inlet system on modified Model 747-8 airplanes as part of FAA STC project No. ST00483MC-T.

Issued in Des Moines, Washington on June 8, 2021.

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