Exemption No. 10905

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98057-3356

In the matter of the petition of **The Boeing Company** for an exemption from §§ 25.901(c) and 25.981(a)(3) of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2012-1137**

TIME-LIMITED PARTIAL GRANT OF EXEMPTION

By letter dated October 18, 2012, Douglas M. Lane, Director, Regulatory Administration, The Boeing Company, P.O. Box 3707, Seattle, WA 98124, petitioned the Federal Aviation Administration (FAA) for an exemption from the requirements of §§ 25.901(c) and 25.981(a)(3) of Title 14, Code of Federal Regulations (14 CFR). This exemption, if granted would allow planned changes to the fuel quantity indication system (FQIS) for the fuel quantity processor unit (FQPU) parts obsolescence modification on the 737-600/-700/-700C/-800/-900/-900ER (also referred to as the 737NG).

The petitioner requests relief from the following regulation(s):

> Section 25.901(c) – *Installation*. For each powerplant and auxiliary power unit installation, it must be established that no single failure or malfunction or probable combination of failures will jeopardize the safe operation of the airplane except that the failure of structural elements need not be considered if the probability of such failure is extremely remote.
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> Section 25.981(a)(3) – *Fuel tank ignition prevention*. (a) No ignition source may be present at each point in the fuel tank or fuel tank system where catastrophic failure could occur due to ignition of fuel or vapors. This must be shown by: (3) Demonstrating that an ignition source could not result from each single failure, from each single failure in combination with each latent failure condition not shown to be extremely remote, and from all combinations of failures not shown to be extremely improbable. The effects of manufacturing variability, aging, wear, corrosion, and likely damage must be considered.

Related sections of 14 CFR

Section 25.1309 – *Equipment, systems, and installations*, states that required equipment, systems, and installations be designed to ensure that they perform their intended functions under any foreseeable operating condition and that the occurrence of any failure condition that would prevent the continued safe flight and landing of the airplane be extremely improbable.

The petitioner supports its request with the following information:

This section quotes the relevant information from the petitioner's request. 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-2012-1137.

Description of Issue

Boeing and its suppliers have been producing the 737NG for fourteen years and have successfully delivered more than 4200 of these highly reliable airplanes to satisfied customers. As it is to be expected after a very long and successful production run, improvements will be needed to adjust for such things as parts obsolescence and manufacturing process improvements. Three such changes are currently planned that will require Boeing to modify the FQPU and two runs of FQIS wiring.

The 3 changes include:

- Upgrade the FQPU for obsolete parts
- Re-route and separate FQIS wire between station 397.1 and 400 as part of a production improvement which will relocate the forward bulkhead
- Re-route the in-tank FQIS wire along the side of body rib as part of a production improvement that will change that rib to a semi-monolithic part.

In making these changes without an approved exemption, Boeing believes that they would be held accountable for showing full compliance to 25.901(c) Amendment Level 126 and 25.981(a)(3) Amendment Level 125 for the FQIS at the system level which would require a significant number of changes associated with the FQIS tank-side circuit.

The system has been shown compliant to §25.1309; however, presently both §25.901(c) and §25.981(a)(3) have additional failure combination requirements. For systems that may cause a catastrophic hazard, §25.1309 requires no single failure and no combination of failures greater than extremely improbable; §25.901(c) requires no single failure or probable combination of failures; and §25.981(a)(3) requires no single failure, no single plus latent (greater than extremely remote), and no multiple combination greater than extremely improbable.

This exemption is being sought for the no single plus latent (greater than extremely remote) as is stated in §25.981(a)(3) and interpreted by the FAA for §25.901(c). An exemption is also being sought for the non-environmental aspects of §25.901(c) provided

by FAA interpretation, and the explicit §25.981(a)(3) requirements of manufacturing variability, aging, wear, corrosion, and likely damage, as these considerations are already covered by factory manufacturing processes, and airline maintenance of the type design of airplane.

In April of 2006 a production change aimed at developing and incorporating a Transient Suppression Device (TSD) for non-densitometer equipped airplanes and a Remote Data Concentrator (RDC) for densitometer equipped airplanes was canceled. This development effort was pursued in parallel with the Nitrogen System Generation System (NGS) development effort and when the decision was made to incorporate NGS as the means to minimize center tank flammability Boeing suspended further activity on this production change. Boeing believed that NGS protected against all potential ignition sources and not just FQIS wiring. Boeing also believed that their position was consistent with what was later documented in the FAA Reduction of Fuel Tank Flammability in Transport Category Airplanes; Final Rule, July 21, 2008. In section K. Cost/Benefit Analysis of this final rule, it is stated that "Since this rule requires FRM or IMM to mitigate an unsafe condition by converting these tanks into low flammability fuel tanks, TSUs will no longer be needed."

In 2009 Boeing completed an evaluation comparing the effort and cost required to implement a compliant FQIS by isolating the intrinsically safe side wire through wire separation or by adding barrier devices. Both of these solutions were found to be technically challenging and expensive. The recurring cost for adding barrier devices was much greater than the cost to separate the FQIS wire. In addition the following challenges associated with incorporating such a barrier device had been identified:

- The Transient Suppression Device (TSD) would not work with the densitometer as it is a passive filter and it would interfere with the densitometer circuitry, so a Remote Data Concentrator (RDC) would be needed.
- The RDC's would need to be mounted in unpressurized regions of the airplane near the tank penetration to minimize the need for wire separation. This represented a challenging temperature and vibration environment for this type of microprocessor centric device. For example, the wing mounted devices would be adjacent to the anti-ice duct.
- There was no clearly identified space near the tank penetrations that would accommodate an RDC.
- The FQPU would require modifications and requalification as the signal conditioning function would be moved from the FQPU out to the RDCs. The FQPU would act as an interface between the RDCs and the avionics. This level of architectural change would add additional cost and complexity.
- Because RDCs are microprocessor based devices the cost would be higher than that for the TSD.

Due to the high recurring cost and technical complexity associated with the barrier device solution, Boeing had determined that if full compliance to 25.981 at amendment level 102 were required, the following changes would need to be incorporated on the 737-600/700/700C/800/900/900ER airplanes:

- Extensive redesign of the Airplane Wiring System to ensure FQIS wire separation for more than 100 unique customer driven airplane configurations.
- Modify the FQPU mother board and associated connectors. The solution would require the FQPU to grow in size.
- Relocate the FQPU from the Forward Equipment Center to the forward cargo compartment to allow for a larger FQPU and enable a clear path for wire separation.
- Make new main tank penetrations in-board of the struts and procure new in-tank wiring harnesses.
- In-tank Component Changes (new brackets, shorter probe, revised in-tank wire harness and retention means).
- Software changes related to Fuel Tank Gauging Function (to account for capacitance change due to in-tank component changes).

The time needed to successfully implement these changes would extend beyond the fourth quarter of 2014. This is when the FQPU obsolete parts would be completely consumed leaving no additional parts for building production FQPUs or supporting the fleet with repaired or replaced units. Operators would be required to incorporate the extensive changes described above in retrofit prior to replacing a malfunctioning FQPU of the current configuration with a new one. Boeing views this as an excessive burden on their customers that does not provide a proportionate improvement in safety or reliability of the FQIS. However, Boeing does remain committed to making incremental safety enhancements to the 737NG fuel system. We believe that making these changes does not have an adverse affect on this system, but in fact enhances what is already a proven good in-service safety record. As such, Boeing is requesting that the FAA consider this petition for exemption for 14 CFR 25.981(a)(3) Amendment 25-125 and 14 CFR 25.901(c) Amendment 25-126 for the three changes that impact the FQIS as described in more detail below:

With regard to the 737NG FQPU, several electronic components within the Signal Conditioning Circuit Card (SCCC) have become obsolete. The inventory of the obsolete parts available only supports production through 2014. As a result, a redesign of the SCCC within the FQPU is required to provide a solution for this typical type of product lifecycle parts obsolescence situation. The redesigned SCCC will meet the requirements of 25.981(a)(3) per AC 25.981-1C and will therefore provide an additional level of safety in the FQPU as compared to the current configuration.

To gain more room in the EE bay to support a more producible and ergonomic configuration, the forward bulkhead will be relocated from Station 397.1 to Station 401 and there will be an associated redesign of wiring in that area (transverse rack and cross over wiring). The associated FQIS wiring will be separated from the other wiring between station 400 and 420 which will add an incremental safety improvement.

In order to support a production rate increase and improve manufacturability, Boeing plans to implement a semi-monolithic side of body rib change which will significantly reduce the complexity of that build. As part of this structural change, the current stiffeners located on the inboard side of the rib will be moved to the outboard side which

will require that the center fuel tank FQIS wiring be moved outboard approximately 2 inches from its current routing. The FQIS wire run is located entirely in the center tank and this change will not degrade the safety of the system.

Below listed are the incremental improvements Boeing has opportunistically made over time to add increased levels of safety to the FQIS. These and other future improvements include:

2005: A hot short protector was added to the densitometer installation
2008: NGS was incorporated into production
2011: NGS Retrofit Service Bulletin provided for US Operators
2011: Analysis was completed showing the FQPU as a barrier device which inhibits the
propagation of up-stream hot shorts of up to 115VAC onto the intrinsically safe FalS wiring
2014: FQIS wire will be separated between station 400 and 420 - as part of the forward bulkhead relocation change
2014: The SCCC will be 25.981 compliant - as part of the FQPU parts obsolescence upgrade
Beyond 2014: The 737MAX FQIS will be made fully 25.981 Amendment 125 compliant.

In summary, this exemption will be applied such that today's certified FQIS configuration will largely remain the same until the introduction of the 737MAX and it will continue to include the following specific features:

- The FQPU motherboard is not compliant to UL 913 for circuit board trace separation
- The tank-side FQIS wiring is not separated from other airplane system wires
- The failure of two in-tank wire clamps could allow wire to make contact with structure
- The failure of a tank unit clamp screw could allow the unit to make contact with structure
- Tank unit separation from structure may not provide redundant lightning protection
- Leading edge FQIS wire shield lacks redundancy.

Statement of Public Interest

The granting of this exemption is in the public interest for the following 2 reasons:

1. The three changes described above do not degrade the current level of safety on the 737NG and in the case of the SCCC modification and the bulkhead relocation an additional level of safety to the FQIS system would be achieved.
2. Denial of this petition for exemption would result in the operators having to perform extraordinary work which would result in disruption of operations and would pose significant burden on the airlines whenever an in-service FQPU fails. The

potential for unidentified collateral damage during this extensive modification is likely more significant than any safety benefit achieved by implementing the improvements.

Statement of No Adverse Effect on Safety

The current FQIS system has been thoroughly evaluated for safety aspects in such forums as Boeing's safety assessment that was required per 14 CFR Special Federal Aviation Regulation No. 88 (SFAR88) for the Fuel Quantity Indicating System and no safety issues were identified other than a single failure mode on the densitometer that was corrected by mandating the hot short protector. However, the FAA's review of that assessment per SFAR88 Mandatory Action Decision Criteria resulted in release of an FAA AD-Worksheet (Worksheet Number 04-AD-59) related to the Fuel Quantity Indicating System for the Center Fuel Tank only, primarily due to its classification as a High Flammable Fuel Tank. Boeing believes that this classification has since been changed due to the installation of a Nitrogen Generation System (NGS) for the center fuel tanks of all 737-600/700/700C/800/900/900ER airplanes as required by the Fuel Tank Flammability Reduction Rule. Note that even prior to the implementation of NGS which further reduces any risk, the Boeing assessment was that the risks for the 737NG FQIS installation were extremely improbable, which is the typical industry and CFR 25.1309 standard for an acceptable systems installation.

The FQPU, SCCC parts obsolescence driven design changes will be shown compliant to UL 913 per the guidance documented in section 10(c)(9) of AC 25.981-1C which will provide for an additional level of FQIS safety. In addition, the FQIS wiring changes associated with the semi-monolithic side of body change and the forward bulkhead relocation will not adversely affect safety; therefore, Boeing requests that this exemption be approved allowing for these changes without requiring the additional changes required to show the FQIS compliant to 14 CFR 25.901(c) Amendment Level 126 and 25.981(a)(3) Amendment Level 125.

Request to ‘Waive Publication and Comment’

The relief sought by this exemption does not result in any reduction in level of safety for a previously type certificated product with a highly reliable system; rather, it allows for an incremental enhancement to the level of safety of the product. The exemption would result in an overall enhancement in the product’s safety and because the current configuration cannot be sustained beyond 2014, Boeing respectfully requests that in order to expedite the exemption process the FAA waive the requirement for publication and comment.

Privileges of the Exemption Outside the United States

Because the 737NG is used by customers around the world, Boeing requests that the privileges of this exemption be extended outside the United States, per 14 CFR 11.81(h) This extension of privileges is necessary for operations based within foreign countries having bilateral agreements with the United States accepting FAA 14 CFR part 25 as their airworthiness standards for transport category aircraft.

Conclusion

Boeing is petitioning for an exemption from the provisions of 14 CFR 25.901(c) [25-126] and 25.981(a)(3) [25-125] at the system level as they apply to the FQIS installed on the 737-600/700/700C/800/900/900ER airplanes for the FQPU parts obsolescence modification, the semi-monolithic side of body and forward bulkhead production improvement changes.

The re-design of the SCCC of the FQPU is necessary due to obsolescence of several electronic components. The re-designed SCCC assembly will not adversely affect the FQIS safety and will be shown to meet the requirements of 14 CFR 25.901(c) and 25.981(a)(3). The existing level of safety will be improved at the card level. In addition the changes made to the FQIS wiring runs associated with the semi-monolithic side of body change and the forward bulkhead relocation add an incremental improvement to the FQIS level of safety.

FAA Approval of this exemption request will allow use of this improved interchangeable LRU (SCCC) for repairs without extensive rework to an in-service aircraft.

***Federal Register* publication**

Although the petitioner requested that action on its petition not be delayed for publication in the *Federal Register*, the FAA found that the petition, if granted, would set a precedent. Therefore, to allow an opportunity for the public to comment on the petition, a summary of it was published in the *Federal Register* on December 4, 2012 (77 FR 71865). Comments were received from the National Air Traffic Control Association (NATCA) National Safety Committee. The commenter agreed with granting a time-limited exemption for in-service airplanes to support needed spare parts. However, they did not agree with granting a permanent exemption for production airplanes. NATCA recommended the FAA not grant the exemption requested in the petition for exemption submitted in docket number FAA-2012-1137 for newly produced airplanes. They recommended instead that the FAA require newly produced airplanes produced in 2014 to comply with the regulations. To facilitate continued operation of in-service 737s, NATCA recommended only granting a time-limited exemption for the existing fleet of airplanes. That would provide the minimum time necessary for operators to modify their existing airplanes so the installation complies with the regulations listed in the petition for exemption. This would be consistent with and compliment issuance of the airworthiness directive (AD) required by FAA policy memorandum PS-ANM100-2003-112-15, “SFAR 88 – Mandatory Action Decision Criteria,” dated February 25, 2003, for the airplanes covered by this petition for exemption.

NATCA supported their recommendations as follows:

NATCA has reviewed the subject petition for exemption and has similar concerns as those raised in our comments to the 757 NPRM (see docket item FAA-2012-0187-0005) and the similar petition for exemption for the Model 767 airplanes (docket FAA-2012-1132). NATCA questions how allowing the noncompliant design features described in the petition for exemption to remain in 737 airplanes indefinitely "would not adversely affect safety, or how the exemption would provide a level of safety at least equal to that provided by the rule from which you seek the exemption" (see 14 CFR 11.81). Those

> design features are defined by the FAA as unsafe in airworthiness directives issued for similar designs on 747 and 737 classic model airplanes and in the FAA's own published SFAR 88 "Mandatory Action Decision Criteria" document; FAA Memorandum number 2003-112-15, dated February 25, 2003. Granting an exemption for a "phased compliance" approach clearly doesn't provide the level of safety that requiring an initially compliant design would provide. The petition states that they would not be able to deliver 737s past the fourth quarter of 2014 without an exemption. Therefore, NATCA recommends the FAA not grant the Petition for Exemption submitted in docket number FAA-2012-1137 for newly produced airplanes and instead require newly produced airplanes produced in 2013 *[sic 2014]* comply with the regulations.

The FAA's analysis

In June of 2011 Boeing met with the FAA to describe the changes to the 737NG FQIS that are the subject of this exemption request. The FAA informed Boeing that we could not approve modifications to the FQIS since the ignition source prevention features of the system could not be shown to meet § 25.981 at amendment 25-102. We also reminded Boeing of our decision to issue SFAR 88 related ADs for FQIS and of our letters of August 2009 and April 2011 requesting Boeing develop design changes and service information describing the corrective actions for FQIS protection. Boeing stated in their request:

> However, the FAA's review of that assessment per [14 CFR part 21 Special Federal Aviation Regulation No. 88 (SFAR 88)] Mandatory Action Decision Criteria resulted in release of an FAA AD-Worksheet (Worksheet Number 04-AD-59) related to the Fuel Quantity Indicating System for the Center Fuel Tank only, primarily due to its classification as a High Flammable Fuel Tank. Boeing believes that this classification has since been changed due to the installation of a Nitrogen Generation System (NGS) for the center fuel tanks of all 737-600/700/700C/800/900/900ER airplanes as required by the Fuel Tank Flammability Reduction Rule.

The petitioner's justification for requesting a permanent exemption to §§ 25.901 and 25.981 relies largely on the availability of a design modification, installation of NGS, that provides fuel tank flammability reduction means (FRM) meeting criteria determined to be equivalent to the standards established by the FAA through the Fuel Tank Flammability Reduction (FTFR) rule introduced into 14 CFR part 25 at Amendment 25-125. However, not all 737 series airplanes in the fleet are required to be retrofitted with NGS.

Mandating retrofit of FRM was found to be in the public interest on newer transport airplanes in passenger service with high flammability fuel tanks. All 737 series passenger airplanes operated in the United States under 14 CFR parts 121, 125, and 129 will be required to have FRM. However, FRM is not required to be incorporated into cargo airplanes, airplanes operated under 14 CFR parts 91 and 135, and airplanes operated in foreign countries unless the foreign country has adopted regulations that implement the fleet safety improvements provided by FRM.

For clarity, we do not agree with the petitioner's statement that, "The current FQIS system has been thoroughly evaluated for safety aspects as was required per SFAR 88 for the Fuel Quantity Indicating System, and no significant safety issues were identified." As identified in the notice of proposed rulemaking (NPRM) for 757 series airplanes, Docket No. FAA-2012-0187, the FAA

intends to issue ADs for other airplane models, such as the 737, with high flammability fuel tanks that are not required to retrofit FRM. These ADs will incorporate FQIS protection to prevent potential sources of fuel tank ignition per SFAR 88. This includes all airplanes in cargo operation and airplanes in 14 CFR part 91 and 135 operations. The ADs are expected to affect many foreign-registered airplanes produced before Boeing incorporated NGS in production in 2008 as well. We are currently preparing a supplemental NPRM to add another method of compliance for airplanes in cargo operation in order to achieve an acceptable level of safety for those airplanes. Boeing is required by §§ 21.99 and 183.63(d) to submit appropriate design changes as well as service information for FAA approval and has agreed to do so in a timely manner to support these ADs. We do not anticipate that changes to the FQIS resulting from these planned ADs will involve changes to the FQPU itself but may include some or all of the wire separation-related design changes planned by Boeing with additional wire separation as well.

The FAA's current fuel tank safety airworthiness standards rely upon a balanced approach of limiting fuel tank flammability exposure time and precluding ignition sources that could form in the fuel tanks. For this reason, § 25.981 includes separate and distinct requirements for limiting fuel tank flammability and preventing ignition sources in the fuel tanks.

The Boeing NGS was shown to meet criteria equivalent to the flammability requirements of § 25.981, Amendment 25-125; however, fuel tank ignition failure modes described in the petition for exemption do not comply with the ignition prevention requirements of § 25.901(c), Amendment 25-46, or § 25.981(a)(3), Amendments 25-102 or 25-125. When considering the FQPU design change along with the partial wire separation planned by Boeing, that design change has no negative effect on potential fuel tank ignition and no negative effect on the level of safety in the 737 FQIS. However, granting a permanent exemption would not provide a level of safety at least equal to that provided by the rule from which Boeing seeks the exemption (see 14 CFR 11.81) because areas affected by this change would not be compliant, as required by § 21.101.

NATCA recommended the FAA not grant the petition for exemption for newly produced airplanes, but instead recommended a time-limited exemption for in-service airplanes only to allow the operators to replace FQPUs on 737s as needed and to require newly produced airplanes fully comply. We partially agree. Completing the design changes necessary to fully comply with the fuel tank ignition prevention standards of §§ 25.901(c), Amendment 25-46, and 25.981(a)(3), Amendment 25-102 or 25-125, and incorporating the changes into newly-produced airplanes will further reduce the risk of fuel tank ignition and enhance safety by restoring the balanced approach to fuel tank safety required by 14 CFR part 25. However, the changes described by Boeing in the exemption request that are needed to directly comply are extensive and more time would be needed to complete the design and incorporate it into production.

Not granting the exemption would not be in the public interest because it would result in delivery delays for newly manufactured airplanes due to this proposed change to the FQPU and FQIS partial wire separation. Also it would not allow operators to replace FQPUs on in-service airplanes when replacements are needed, without unintended impact to scheduled operations. In addition, the timing of the transition from the 737NG to the next planned version of the 737 series, the 737-7/-8/-9 (also referred to as the 737Max), contributes to a determination that full compliance for the 737NG FQIS is not practical. Therefore, partial grant of exemption is in the

public interest. Boeing plans for the 737Max FQIS to fully comply with the fuel tank ignition prevention requirements.

As indicated in the 757 FQIS NPRM, the FAA plans to mandate FQIS protection similar to that discussed in the NPRM on other Boeing airplanes, which includes the 737 series airplanes. The AD planned for the 737 series is expected to incorporate the long term FQIS protection for airplanes to which this exemption applies. Boeing is required by 14 CFR 21.99 and 183.63(d) to develop design changes and service information describing the corrective action for FQIS protection. Boeing has committed to provide the data necessary to support these modifications mandated by the ADs in a timely manner to support these ADs.

The FAA's decision

In consideration of the foregoing, I find that a partial grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701 delegated to me by the Administrator, The Boeing Company is hereby granted a time-limited exemption for up to 48 months after the effective date from 14 CFR 25.901(c), Amendment 25-126, and 25.981(a)(3), Amendment 25-102 or later, as they pertain to fuel tank ignition prevention associated with the following FQIS changes on in-service and newly-produced 737-600/-700/-700C/-800/-900/-900ER airplanes:

- Replacement of the SCCC and the ARINC display card within the FQPU; and
- Changed areas for the re-routing and separation of FQIS wires where the changed areas of the FQIS wire routing meet the installation requirements for separation and fault tolerance required to comply with § 25.981(a)(3) as associated with the:
    - Semi-monolithic side-of-body change, and
    - Forward bulkhead relocation.

After expiration of this time-limited exemption, the FQIS on all newly-produced airplanes must be shown to comply with §§ 25.901(c), Amendment 25-46, and 25.981(a)(3), Amendment 25-102, or later amendments.

Issued in Renton Washington, on December 18, 2013.

/s/ Jeffrey E. Duven

Jeffrey E. Duven
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