Exemption No. 9405

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056

In the matter of the petition of **THE BOEING COMPANY** for an exemption from § 25.901(c) of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2007-28798** **(See also Docket No. FAA-2003-14201)**

PARTIAL GRANT OF EXEMPTION

By letter dated December 19, 2002, Mr. Daniel Blankinship, Manager, Airplane Certification, The Boeing Company, P.O. Box 3707, Seattle, Washington 98124-2207, petitioned for an exemption from the "no single failure criteria" of § 25.901(c) of Title 14, Code of Federal Regulations (14 CFR) as it relates to "uncontrollable high thrust failure conditions." Recent studies and service experience indicate that some existing transport category airplanes do not strictly comply with § 25.901(c) for certain uncontrollable high thrust failure conditions. The proposed exemption, if granted, would permit type certification of similarly non-compliant derivatives of the current Boeing Model 757 airplane.

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

> Section 25.901(c) requires in part that "no single failure will jeopardize the safe operation of the airplane."

The petitioner supports its request with the following information:

There are improvements to the propulsion control system that are immediately available on some product lines. Timely response to this petition will enhance the safety of the fleet by making these improvements available. The nature of this petition for exemption is similar to previously granted exemptions for the Airbus models A340-500, A340-600, the Embraer models EMB-135BJ, EMB-145XR, and the Boeing Model 757-300.[1]

A committee consisting of representatives from the FAA, the JAA, airplane manufacturers, and engine manufacturers was formed in 1998 to study strategies for providing additional protection from thrust control malfunctions resulting in un-commanded high thrust. The committee found (see reference report[2]) that for the existing in-service airplanes, whose propulsion systems have demonstrated a level of reliability on the order of one un-commanded high thrust event per 10 million flight hours, it would not be in the public interest to mandate major and novel design changes in an attempt to eliminate the already small potential exposure to un-commanded high thrust malfunctions resulting from single failures. The committee's recommended approach to ensure continued high levels of reliability for all presently certified models is to monitor in-service performance and, if any unacceptable failure modes are identified, to take prompt corrective action by introducing focused design improvements using proven technology.

The approach of taking action to correct specific problems as they are identified has been used successfully for many years on the Boeing models for which this exemption is requested. The Boeing fleet has maintained a high level of safety and reliability. It is in the public interest to allow prompt certification and introduction of design improvements that enhance propulsion system reliability and safety as well as other type design improvements that have no direct bearing on the failure modes leading to un-commanded high thrust. Full compliance with 14 CFR 25.901(c) would require introduction of costly, complicated, and novel design changes to the existing fleet, which are not warranted in light of the presently demonstrated high level of safety and reliability. Mandating such

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[1] A Grant of Exemption from § 25.901(c) for Boeing Model 757-300 (Exemption No. 7798) was issued on June 4, 2002, in response to letters dated June 29, 2001 and November 8, 2001, from The Boeing Company. In response to the current petition (dated December 19, 2002), Partial Grants of Exemption have been issued for Boeing Models 777; 737; 767; 747; and DC-9, MD-91, MD-80, and 717.

[2] Reference to the report of this committee was contained in the current petition for exemption submitted by The Boeing Company. That petition can be viewed in its entirety on the Internet in the Docket Management System (DMS) at www.dot.gov. Select Dockets, then Docket Management System. Perform a Simple Search by entering the Docket Number. This will bring up a list of one or more documents which you may view and copy.

compliance whenever an incremental change is made to a presently certified type design would discourage voluntary changes intended to improve the reliability and safety of the fleet. Therefore, it is in the public interest for the FAA to grant a partial exemption to 14 CFR 25.901(c), as described above.

Notice and Public Procedure Provided

A summary of this petition was not published in the Federal Register, as the nature of this exemption is effectively identical to those of previous petitions for which there were no public comments received.

The Federal Aviation Administration's (FAA) analysis is as follows:

Background

Uncontrollable High Thrust Failure Conditions
Numerous single and anticipated combinations of failures within traditional turbojet engine control systems result in losing the normal means to control thrust (i.e., control via the throttle lever, autothrottle, etc.). A subset of the resulting failure conditions may include actual thrust either increasing to higher than commanded and/or remaining high when low thrust is commanded. These “Uncontrollable High Thrust Failure Conditions” and the hazards they pose have long been inherent in transport airplane designs. In fact, the “fail-safe” states for engine controls have traditionally been chosen to protect high thrust capability and allow the flightcrew to decide when an engine shutdown is appropriate.

An initial estimate indicates that over the last 20 years, the average rate of occurrence for the uncontrollable high thrust failure condition on turbofan-powered large transport category airplanes has remained relatively constant at around one every 2.5 million flight hours. This would indicate that to date an “Uncontrollable High Thrust Failure Condition” has occurred hundreds of times without resulting in a single reported serious injury.

When these failure conditions were identified during past certifications, compliance was typically based on accepting an assertion that the flightcrew will recognize and safely accommodate the loss of the normal means to control engine thrust, including shutting down the affected engine via an independent fuel shutoff as required. However, engineering studies and service experience, including a 1997 Saudi Arabian Airlines Boeing 737-200 accident, indicate that this traditionally accepted assertion is not always valid. For those airplanes re-evaluated to date, the FAA has determined that the available failure recognition and accommodation time under certain anticipated operating conditions is so short and the required corrective actions sufficiently unnatural that the flightcrew cannot be relied upon to reliably and completely perform those actions before the safe operation of the airplane is jeopardized.

While the focus of this petition was on the impacts of this determination on compliance with the general objective requirement of §25.901(c) relating to single failures, the FAA recognizes that this determination may have a similar impact on compliance with other regulations. The FAA has concluded that, by addressing all the potential impacts of this determination on compliance with the general requirements of §25.901(c), we will inherently cover the scope of potential impacts on all other applicable regulations. Consequently, while this documentation and the resultant granting specifically discuss only §25.901(c), they implicitly cover all applicable regulations impacted by this determination.

The FAA is responding to the full scope of this determination by developing a "Thrust Control Malfunction Airworthiness Program" to consistently and objectively assess and manage the existing and future transport airplane fleet risks associated with this endemic potential for non-compliance and unsafe conditions. The ultimate goal of this program will be to bring the transport airplane fleet back into compliance as quickly as practicable. The interim goal of this program will be to manage the risk associated with each instance of non-compliance so that it does not represent an unsafe condition.

In the interim, for type certification the FAA has begun requesting more effective validation of any assertion that the flightcrew will recognize and safely accommodate the loss of the normal means to control engine thrust. A series of such requests is what led Boeing to submit the subject, generally applicable, petition. Until practicable design solutions can be identified, validated, and safely integrated into turbine engine control system type designs, it is clearly in the public interest to continue to certificate type design improvements, even if they don't strictly comply with the reference standard.

Boeing Model 757

This exemption is applicable to all Boeing Model 757 type design changes to be approved under Type Certificate Number A2NM after the date of this granting.

For all such Boeing Model 757 designs, the petitioner intends to demonstrate that those combinations of failures that could jeopardize safe operation comply with § 25.901(c) in that they are not "probable combinations."[3] Conversely, the petitioner does not always intend to demonstrate that those single failures which could jeopardize safe operation comply with § 25.901(c).

Compliance with § 25.901(c) requires that each identified single failure be assumed to occur under all anticipated combinations of airplane operating and environmental conditions. While

[3] The term "probable," as used in § 25.901(c) has a very different meaning from the same term as subsequently used in association with § 25.1309(b) compliance. As used in §25.901(c), "probable" means "foreseeable." In §25.1309(b) terms, this means the subject failure conditions are "anticipated to occur" (i.e., they are not "extremely improbable").

the single failures themselves must be assumed to occur regardless of their probability,[4] probability can be considered when determining what combinations of operating and environmental conditions are anticipated to occur in the fleet life of the airplane type. Single failures do not need to be assumed to occur under conditions that are in and of themselves not expected to occur.

All of the currently certificated Boeing 757 designs are known to have single failures that will cause uncontrollable high thrust. Consequently, it is expected that some, if not all, future derivatives of these designs may also have such single failures. Uncontrollable high thrust under certain anticipated takeoff and landing conditions is expected to jeopardize the safe operation of these derivative Boeing 757 airplanes.

In order to certificate such derivative Boeing 757 airplanes, the petitioner must either obtain this exemption or substantially modify the type designs before any such derivative designs, including obvious product improvements, can be approved. As delineated in the petitioner's supporting information, the petitioner contends that having the exemption available as a certification option when design changes don't increase the risks associated with the subject non-compliance is in the best interest of the public.

The engine control systems for the existing variants of the Boeing 757 are modern full authority digital engine control (FADEC) based systems, and, as such, future design changes should provide opportunities to significantly reduce or even eliminate the subject non-compliance. The conditions established by the FAA for granting this exemption, when applied to each proposed design change, are intended to take full advantage of each practicable opportunity for improvement while affording the petitioner all warranted flexibility to certificate non-compliant derivative designs.

FAA Analysis – Introduction

To obtain this exemption, the petitioner must show, as required by § 11.81(d), that granting the request is in the public interest, and, as required by § 11.81(e), that the exemption will not adversely affect safety or that a level of safety will be provided that is equal to that provided by the rules from which the exemption is sought.

[4] While probability has been an acceptable means of supporting a finding that a particular "combination" of failures is not "probable," any single failure where the physics of the failure can be identified is typically "anticipated to occur," unless that occurrence within the relevant exposure can be clearly and acceptably ruled out, as is the case for those structural failures specifically excepted by the rule itself.

FAA Analysis - Public Interest

If the FAA were to deny this petition, that would have the effect of preventing certain product improvements from being voluntarily proposed. The petitioner will be required by the conditions for granting this exemption to demonstrate that all practicable actions have been taken to minimize the adverse effect on safety associated with granting this exemption from § 25.901(c) for each applicable design change. This condition assures that granting the exemption will be in the public interest. That is, any risks associated with a known non-compliance must be eliminated or further reduced wherever the FAA finds that to do so is technologically feasible and cost beneficial for the public. This has traditionally been accepted as the level of safety which is "in the public interest." Furthermore, if bringing the airplane into compliance is found to be a "practicable action," then this exemption would in effect be self eliminating.

In consideration of the above, the FAA concludes that granting this petition is in the public interest.

FAA Analysis - Effect on Safety

The petitioner will be required by the conditions for granting this exemption to demonstrate that the risks due to uncontrollable high thrust failure conditions on any airplane certificated under this exemption will not exceed those currently known and accepted for comparable existing transport category airplanes. Making this a condition of this exemption, in combination with the condition to minimize that risk, means that granting this exemption should not adversely affect and, in fact, should improve the average per flight hour risk within the current transport airplane fleet.

For those existing transport airplanes re-evaluated to date, the conditions under which an uncontrollable high thrust failure may jeopardize the safe operation of the airplane are limited to specific aborted takeoff or approach and landing scenarios. Given that these scenarios occur, there is still a low probability that a serious injury will result. This limited exposure, in conjunction with the historically low occurrence rates, makes this a relatively low risk per flight hour. This assessment is supported by the fact that the 1997 Saudi Arabian Airlines Boeing 737-200 accident is the only one attributed to these types of failures and that there were no serious injuries in that accident.

It is the spectre of this low risk per flight hour accumulating indefinitely on many, if not most, existing and future transport airplanes that is the primary concern driving development of the FAA "Thrust Control Malfunction Airworthiness Program." To date, corrective actions under 14 CFR part 39 have been deemed warranted only when the uncorrected risks for a particular type design were considered significantly greater than those allowed by the conditions and limitations of this exemption. Given that these conditions and limitations require that any airplane certificated under this exemption have an uncontrollable high thrust failure rate over three times better than the current fleet average, the impact of adding these Boeing Model 757

fleet hours to the overall transport fleet exposure should be insignificant. Furthermore, if as part of the "Thrust Control Malfunction Airworthiness Program," the FAA determines that additional generally applicable precautions must be taken, including perhaps some future introduction of a compliant design, these will further minimize any cumulative risk impact of granting this exemption.

This exemption allows a somewhat greater hazard than full compliance with § 25.901(c). This is why the FAA intends to bring the transport fleet back into full compliance as soon as practicable. Nevertheless, the fact that the per flight hour risks associated with this non-compliance are low allows us to develop a well considered recovery program to assure that we don't introduce a problem which is worse than the one we are trying to solve and that this recovery program is clearly in the public interest.

In consideration of the above, the FAA concludes that granting this petition will not adversely affect safety.

The Partial Grant of Exemption

In consideration of the foregoing, I find that a partial grant of exemption is in the public interest and will not adversely affect safety. Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701, delegated to me by the Administrator, The Boeing Company is granted an exemption from § 25.901(c) to the extent necessary to allow type certification of all Boeing Model 757 type design changes to be approved under Type Certificate A2NM after the date of this granting without an exact showing of compliance with the requirements of § 25.901(c) or other applicable regulations as they relate to single failures resulting in uncontrollable high thrust conditions. This exemption is subject to the following conditions and limitations:

1. The Boeing Company must demonstrate, in accordance with an FAA-approved "Airworthiness Assessment and Risk Management Plan," that all practicable actions have been taken to minimize the adverse effects on safety associated with granting this petition. These must include, but are not limited to, practical actions to eliminate or further reduce the risks by improving designs, procedures, training, and instructions for continued airworthiness.

2. The Boeing Company must demonstrate, in accordance with an FAA-approved "Airworthiness Assessment and Risk Management Plan," that the risks associated with exempting the "uncontrollable high thrust failure condition" from the single failure provisions of § 25.901(c) are no greater for the proposed Model 757 type designs than those currently known and accepted for comparable existing transport category airplanes. Acceptable risk for this provision can be characterized as:

a. The airplane complies with § 25.901(c) for any foreseeable uncontrollable high thrust failure conditions in flight, except possibly during approach below 400 feet; and

b. The expected frequency of occurrence of the uncontrollable high thrust failure condition is less than once per ten million airplane operating hours.

3. The following "Note" will be added to the airplane Type Certification Data Sheet for any airplane certificated under this exemption:

The FAA has concluded that the occurrence of any uncontrollable high thrust failure condition or any of the associated causal failures listed within the Boeing "Airworthiness Assessment and Risk Management Plan" may endanger the safe operation of an airplane. Consequently, the FAA recommends that operators be encouraged to report instances of uncommanded high thrust in accordance with §§ 121.703 (c), 125.409 (c), and 135.415 (c).

In support of this "Note," Boeing must develop and obtain FAA approval of the Boeing document referenced in the "Note." This document lists those failures that can contribute to or cause an uncontrollable high thrust failure condition covered by this exemption. This document shall then be made available as part of the Instructions for Continued Airworthiness. Further, the failures listed within this document shall be added to the list of reportables under § 21.3 for any airplane certificated under this exemption.

4. The granting of this exemption does not relieve any regulatory obligation to identify and correct unsafe conditions related to uncontrollable high thrust failure conditions.

Note 1: Additional background and guidance regarding these provisions are provided in FAA Letter 02-112-02, dated October 19, 2001.

Note 2: Exemption No. 7798, applicable to Boeing Model 757-300 airplanes with Pratt and Whitney 2000 series engines, was the first exemption pertaining to uncontrolled high thrust to be granted by the FAA. A number of refinements have been incorporated into subsequent exemptions pertaining to uncontrolled high thrust, including this exemption which is applicable to all Boeing Model 757 airplanes. In the interest of standardization, as of the date of issuance this Partial grant of Exemption should be used in lieu of Exemption No. 7798.

Issued in Renton, Washington on July 18, 2007.

/s/ Stephen P. Boyd
Acting Manager
Transport Airplane Directorate
Aircraft Certification Service