

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 §§ 25.301, 25.303,
25.305, and 25.901(c) of Title 14, Code of
Federal Regulations

Regulatory Docket No. FAA-2004-17909

TIME LIMITED PARTIAL GRANT OF EXEMPTION

By letters dated March 22, April 1, and April 21, 2005, Mr. D. L. Mauldin, Manager, Aircraft Certification, The Boeing Company, P.O. Box 3707, Seattle, Washington 98124-2207, petitioned for a time limited exemption from the requirements of §§ 25.301, 25.303, 25.305, and 25.901(c) of Title 14, Code of Federal Regulations (14 CFR), for Boeing Model 777 airplanes equipped with Pratt & Whitney and Rolls-Royce engines. To avoid disruption of air commerce, the FAA granted Exemption No. 8329A on July 15, 2004, for the first affected derivative design. This amendment to Exemption No. 8329A, if granted, would extend the expiration date of that exemption.

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

Section 25.301 "Loads," which requires:

“ (a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the airplane. These loads must be distributed to conservatively approximate or closely represent actual conditions. Methods used to determine load intensities and distribution must be validated by flight load measurement unless the methods used for determining those loading conditions are shown to be reliable.

(c) If deflections under load would significantly change the distribution of

external or internal loads, this redistribution must be taken into account.”

Section 25.303 “Factor of Safety,” which requires:

“Unless otherwise specified, a factor of safety of 1.5 must be applied to the prescribed limit load which are considered external loads on the structure. When a loading condition is prescribed in terms of ultimate loads, a factor of safety need not be applied unless otherwise specified.”

Section 25.305 “Strength and Deformation,” which requires:

“ (a) The structure must be able to support limit loads without any detrimental permanent deformation. At any load up to limit loads the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure for at least 3 seconds. However, when proof of strength is shown by dynamic tests simulating actual load conditions, the 3-second limit does not apply. Static tests conducted to ultimate load must include the ultimate deflections and ultimate deformation induced by the loading. When analytical methods are used to show compliance with the ultimate load strength requirements, it must be shown that-

- (1) The effects of deformation are not significant;
- (2) The deformations involved are fully accounted for in the analysis; or
- (3) The methods and assumptions used are sufficient to cover the effects of these deformations.

(c) Where structural flexibility is such that any rate of load application likely to occur in the operating conditions might produce transient stresses appreciably higher than those corresponding to static loads, the effects of this rate of application must be considered.

(d) [Reserved.]

(e) The airplane must be designed to withstand any vibration and buffeting that might occur in any likely operating condition up to V_D/M_D , including stall and probable inadvertent excursions beyond the boundaries of the buffet onset envelope. This must be shown by analysis, flight tests, or other tests found necessary by the Administrator.

(f) Unless shown to be extremely improbable, the airplane must be designed to withstand any forced structural vibration resulting from any failure, malfunction or adverse condition in the flight control system. These must be considered limit loads and must be investigated at airspeeds up to V_C/M_C .”

Section 25.901(c) “Installation,” which requires:

“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.”

The petitioner’s supportive information is as follows:

In letter B-H360-05-0975, dated March 22, 2005, the petitioner states:

“This request for an extension to that partial exemption is made for several reasons, including: 1) a determination that a full scale thrust reverser/engine test would be required; 2) delays in accomplishing the testing; and 3) a better understanding of the time required to implement retrofits on previously delivered thrust reversers. The data from the full scale testing currently underway will be used to guide the development of more accurate analysis methods. Achieving more accurate analysis methods, developing appropriate design solutions, and retrofitting previously delivered airplanes will require more time to implement than anticipated at the time of the original exemption request.

“Since the original exemption request was made, significant progress has been made in demonstrating the safety and compliance of the Model 777 thrust reverser designs. The Model 777 GE90-94B thrust reverser configuration was found to be compliant to the regulations and, as such, that configuration is omitted from this request. An electronic engine control (EEC) software change that reduces the loading on the thrust reverser during a refused take off (RTO) has been developed and implemented on the Rolls-Royce engine. A similar EEC software change has been developed for the Pratt & Whitney engine and is scheduled to be implemented in mid-2005. Limit load RTO demonstration tests have been conducted on both Pratt & Whitney and Rolls-Royce powered airplanes with no adverse results. Also, Model 777 thrust reversers in service have continued to operate safely with no failures or damage to thrust reversers as a result of v-blade disengagement, which is the phenomenon that led to the original request for exemption.

“Therefore, The Boeing Company is requesting an extension of two (2) years (from May 1, 2005) to complete the testing, design, and implementation of modification, if required, for production airplanes, and seven (7) years (from May 1, 2005) for in-service airplanes. Please note that the extension request is being made with the assumption that changes in the nacelle and engine hardware will be required. This assumption will be verified or negated by the completion of the full-scale test and subsequent analysis later this year.”

In letter B-H360-05-1571, dated April 21, 2005, the petitioner further states:

“... the ability of the thrust reverser structure to withstand the partial disengagement of the v-blade with no detrimental effects is much better than previously assumed”;

“... analysis of both the Pratt & Whitney and Rolls-Royce thrust reversers may take up to 12 months from May 1, 2005”; and

“... the revised analysis will confirm the thrust reversers to be compliant with no hardware changes required.”

Notice and Public Procedure Provided

On April 11, 2005 (70 FR 18451), the FAA published notice of the petition for exemption in the Federal Register and requested comments from the public. No comments were received in response to the notice.

The FAA's analysis is as follows:

Background

On June 23, 2003, a GE90-115B thrust reverser inner wall failed during a high power RTO [Rejected Take Off] on a test stand at the General Electric Aircraft Engine facility in Peebles, Ohio. Subsequent investigation of this event revealed previously unrecognized critical aspects of an existing load case which could affect compliance with the subject regulations as they relate to the structural strength, deformation, and failure of thrust reverser inner wall panels. This necessitated development and validation of substantially new finite element structural models and analyses for thrust reversers. Development and validation of these models and analyses has proven more complex than initially thought and hence are taking longer than provided for under time limited Exemption No. 8329A. Although FAA regulations would allow certification and operation of affected Boeing Model 777 airplanes without operational thrust reversers, the FAA considers it to be safer to continue to certificate and operate the affected airplanes with operational thrust reversers, even though strict compliance with the subject regulations has not yet been demonstrated. The implication of the recently discovered loading conditions for the thrust reverser designs already in service is also being investigated. The FAA does not currently consider these implications to be serious enough to warrant an airworthiness directive. However, if subsequent information indicates some mitigating or corrective action is warranted, that action will be taken.

This time limited partial grant of exemption permits Boeing Model 777 airplanes, equipped with Pratt & Whitney or Rolls-Royce engines certificated under time limited Exemption No. 8329A, to operate from May 1, 2005, when Exemption No. 8329A expires, until May 1, 2006, when this time limited partial grant of exemption expires. Further, this time limited partial grant of exemption permits type certification of any additional Boeing Model 777 airplanes with derivative thrust reverser designs covered by the petition without showing strict compliance with the referenced regulations.

To receive a time limited 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.

Public Interest

If the FAA were to deny this petition, the only timely alternative for the petitioner would be to certificate the affected airplanes with both thrust reversers deactivated. The associated performance penalty for operations on wet or otherwise contaminated runways would probably be around 5% of field length. This would require airplane payloads, and hence operating revenues, to be commensurately reduced. Operators currently in possession of affected airplanes would be immediately impacted. Customers awaiting delivery of new affected airplanes would likely either not take delivery or would demand substantial compensation to take delivery. Further, the safety provided by operational reversers could never be completely compensated for by performance penalties. For example, these penalties would not compensate for the loss of the ability to use asymmetric reverse thrust to compensate for braking, steering, or aerodynamic asymmetries during high speed ground deceleration operations. In the view of both the petitioner and the FAA, the risk posed by the potential non-compliance allowed by granting this time limited partial grant of exemption is less than the risk that would be posed by certificating without operational thrust reversers.

The petitioner will be required, by the conditions for granting this time limited partial grant of exemption, to report any information it acquires which might invalidate the justifications given for granting this exemption.

Based on the information available, the FAA concludes that it would be premature to grant the full seven year extension requested by the petitioner. If the analysis confirms compliance by May 1, 2006, as predicted by the petitioner, then any further extension of the exemption will not be required. If this is not the case, the FAA will have the additional information obtained over the next year to aid us in deciding upon the appropriateness of any further extension.

In consideration of the above, the FAA concludes that granting a one year extension to time limited Exemption No. 8329A is in the public interest.

Effect on Safety

Given the extensive good service experience of similar designs and what we know about the structural integrity of the subject thrust reverser inner wall, the FAA does not expect affected designs to experience any critical inner wall failures. However, to reduce the risk of such a failure within the affected fleet, the FAA is proposing to retain the Exemption No. 8329A restriction on dispatch with failures known to pressurize the engine core compartment on the affected Boeing Model 777 airplanes currently in service.

As a condition for granting this time limited partial grant of exemption, dispatch relief for conditions that could pressurize the core compartment will be restricted to three days. This restriction will be made a type design operating limitation. Since the modified thrust reversers subject to this exemption are not expected to pose any greater risk than those already in service, and there are only sixteen airplanes equipped with these modified thrust reversers scheduled to be delivered during the one year period of this extension to time limited Exemption No. 8329A, granting this extension would have negligible effect on the overall risk posed by this potential failure condition within the Boeing Model 777 airplane fleet.

This time limited partial grant of exemption implies a somewhat greater uncertainty, and hence risk, than demonstrating full compliance with 14 CFR 25.301, 25.303, 25.305, and 25.901(c). However, since the time of the initial granting of Exemption No. 8329A, testing and analysis has further enhanced our confidence that these designs are not unsafe. The per flight hour risk predicted by the petitioner is very low even if we assume the design is non-compliant. By restricting the extension to one year, rather than the seven years requested by the petitioner, any exposure to a non-compliant design is minimized to the greatest extent deemed practicable by the FAA.

The petitioner will be required, by the conditions for granting this time limited partial grant of exemption to report any information it acquires, which might invalidate the justifications given for granting this exemption.

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

The Partial Grant of Exemption

In consideration of the foregoing, I find that a one year time limited 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 granted a time limited partial grant of exemption from 14 CFR 25.301, 25.303, 25.305, and 25.901(c) to the extent necessary to allow type certification of the modifications to the thrust reverser type designs of Boeing Model 777 airplanes without a complete showing of compliance. These requirements relate to the structural strength, deformation and failure of the thrust reverser inner wall panels during a rejected takeoff related thrust reverser deployment at high engine power. This time limited partial grant of exemption is subject to the following conditions and limitations:

1. The Boeing Company must report to the FAA any information it acquires which might invalidate the justifications given for granting this exemption.
2. The Type Certificate Data Sheet (TCDS) and Airplane Flight Manual (AFM) must include a type design operating limitation that limits dispatch to three days with any failure condition which could pressurize the core compartment. This includes, but

may not be limited to, dispatch with the Fan Air Valve locked open or the Pressure Relief and Shutoff Valve locked closed.

This dispatch prohibition shall be reviewed by the Flight Operations Evaluations Board (FOEB) for the Boeing Model 777 airplane at the earliest opportunity to consider developing a revision to the Master Minimum Equipment List (MMEL) for all Boeing Model 777 airplanes. This exemption condition, and the associated type design limitations, may be amended based upon the findings of the FOEB or other relevant information obtained subsequent to the date of granting this exemption.

3. Before issuance of the amended type certificate, documentation must be submitted to the FAA which substantiates the petitioner's assertions that: "The airplanes have been shown to be safe."
4. The granting of this partial grant of exemption does not relieve any regulatory obligation to identify and correct unsafe conditions related to thrust reverser inner wall panel failure conditions.

This exemption terminates on May 1, 2006, unless sooner superseded or rescinded. Upon termination of this exemption, any type certification issued by the FAA in consideration of this exemption shall be void unless the Administrator has found compliance with the regulations for which this exemption was granted.

Issued in Renton Washington on April 29, 2005.

/s/ Ali Bahrami
Ali Bahrami
Manager
Transport Airplane Directorate
Aircraft Certification Service