

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 letter dated April 6, 2006, 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 Rolls-Royce engines. To avoid disruption of air commerce, the FAA granted Exemption No. 8329B on April 29, 2005, for the first affected derivative design. This amendment to Exemption No. 8329B, 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-H360-06-1362, dated April 6, 2006, the petitioner states:

“This request for an extension to that original partial exemption, [Exemption No. 8329A], and the subsequent extension,” [Exemption No. 8329B], “is made for several reasons, including: 1) Testing of the Model 777 PW [Pratt & Whitney] thrust reverser took longer than expected, 2) ongoing discussions with the FAA regarding the analysis methodology along with additional complexities in the PW analysis process, and 3) delays in performing/completing the R-R [Rolls-Royce] thrust reverser analysis due to the preceding and subsequent unrelated thrust reverser issues.

“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. The Model 777 PW thrust reverser configuration is also expected to be found compliant prior to May 1, 2006, without any structural modifications. An electronic engine control (EEC) software change that reduces the loading on the thrust reverser during a refused [rejected] take off (RTO) has been developed and implemented for both the R-R engine and PW engines. RTO demonstration tests in excess of limit load have been conducted on both PW and R-R 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, 2006) to [Exemption 8329B] to complete analysis, design, and implementation of hardware modifications if required, for [R-R] powered production 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 analysis.”

In the enclosure to letter B-H360-06-1362, dated April 6, 2006, the petitioner further states:

“Boeing petitioned for a time limited partial exemption from 14 CFR Parts 25.301, 25.302, 25.305, and 25.901(c) (Exemption No. 8329A), specifically as it relates to radial deflection and strength requirements for a thrust reverser as it deploys during a RTO. Boeing subsequently petitioned for an extension to the original time limited partial exemption and was granted one additional year.

“This petition to extend the exemption is requested for the Model 777 airplanes powered by R-R engines. Model 777 airplanes powered by GE90 and PW engines are specifically excluded from this request. Boeing expects to show

compliance to 14 CFR parts 25.301, 25.303, 25.305, and 25.901(c) no later than May 1, 2008. The affected airplanes will be delivered to – or will be operated by – both domestic and foreign operators.

“Boeing requests that this exemption extension be granted by May 1, 2006, in accord with the provisions of 14 CFR part 11.87, allowing for rapid approval of exemptions if good cause is shown in the petition. Timely response to this petition will enhance fleet safety by allowing delivery of airplanes with fully operational thrust reversers.”

### **Federal Register Publication**

The FAA has determined that good cause exists for waiving the requirement for Federal Register publication and comment because the exemption, if granted, would not set a precedent and any delay in acting on this petition would be detrimental to The Boeing Company and affected operators.

### **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 Engines 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 structural finite element models for thrust reversers. Boeing has made significant progress in the structural analysis of the Boeing Model 777 thrust reversers since the start of its investigation. Boeing demonstrated that Model 777 airplanes with General Electric engines are fully compliant with all applicable regulations prior to May 1, 2005, when Exemption No. 8329A expired. Boeing will demonstrate that Model 777 airplanes with Pratt & Whitney engines are fully compliant with all applicable regulations by May 1, 2006, before Exemption No. 8329B expires.

Validation of the Pratt & Whitney thrust reverser structural analysis has proven to be more complex than anticipated, resulting in delays in performing the structural analysis of the Rolls-Royce thrust reverser beyond May 1, 2006. Additional full scale validation testing may be required to support validation of the Rolls-Royce thrust reverser structural analysis.

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 implications of the loading conditions discovered in the 2003 test have been investigated for the GE and PW installations, and will be investigated for the RR installation. The FAA did not conclude that the implications were serious enough to warrant issuance of an airworthiness directive for the airplane with either GE90 or PW engines. However, if subsequent information indicates that some corrective action is warranted, that action will be taken.

This time limited partial grant of exemption permits Boeing Model 777 airplanes, equipped with Rolls-Royce engines certificated under time limited Exemption No. 8329B, to operate from May 1, 2006, when Exemption No. 8329B expires, until May 1, 2008, when this time limited partial grant of exemption expires. Further, this time limited partial grant of exemption permits type certification of design changes to the affected Boeing Model 777 thrust reversers under the terms of this exemption.

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. 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.

The FAA concludes that for production airplanes, granting a two year extension to time limited Exemption No. 8329B is in the public interest. The two years is necessary to give the petitioner sufficient time to complete the analysis, testing,

design, and implementation of hardware modifications, as necessary. The evaluation of the PW engine took more than one year, as some of the activity started prior to the issuance of Exemption 8329B. Additionally, the design loads were lowered substantially due to a change to the engine software, allowing the petitioner to demonstrate compliance to the applicable regulations by test. The petitioner may not be able to use the same approach on the RR engine, and the engineering validation testing on the RR engine may require more sophistication. The two years will still require the petitioner to work the problem aggressively. If it is subsequently determined that the two years is not necessary, e.g., the analysis does not verify that changes in the nacelle or engine hardware are required, the FAA may take action to further limit this time limited partial grant of exemption.

#### 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. Since the 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 the affected thrust reversers scheduled to be delivered during the two year period of this extension to time limited Exemption No. 8329B, granting this extension would have negligible effect on the overall risk posed by this potential failure condition within the Boeing Model 777 airplane fleet.

Since the time of the initial granting of Exemption No. 8329B, 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 two years, any exposure to a non-compliant design is minimized to the greatest extent deemed practicable by the FAA.

As a condition for granting Exemption No. 8329B, dispatch relief for conditions that could pressurize the core compartment was restricted to three days. The limitation is stated as follows:

“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.”

Included with this limitation was the provision that “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.” Since this limitation was identified, Boeing has shown that the load conditions for the affected dispatch configurations are less critical than the load conditions for which the original exemption was granted. Boeing has demonstrated Rolls-Royce thrust reverser structural capability in excess of design limit load for normal dispatch configurations. Boeing has shown that the three day dispatch limitation would have negligible effect on the overall Model 777 fleet risk. The FOEB reviewed this issue as prescribed in Exemption No. 8329B and determined that no revision to the MMEL was necessary. Removal of this limitation will result in a 10 day dispatch limitation per the Boeing Model 777 MMEL dispatch requirement for the conditions that could pressurize the core compartment. Based on this information, the FAA concludes that this limitation can be removed.

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.

### **FAA’s decision**

In consideration of the foregoing, I find that a two 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 equipped with Rolls-Royce engines 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 take off 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. 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.”

3. 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, 2008, 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 27, 2006.

*Signed by Ali Bahrami*

Ali Bahrami

Manager, Transport Airplane Directorate  
Aircraft Certification Service