

**Exemption No. 8613**

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

In the matter of the petition of

**Embraer Empresa Brasileira de Aeronáutica  
S.A. (Embraer)**

for an exemption from § 25.901(c) of Title 14,  
Code of Federal Regulations

**Regulatory Docket No. FAA-2004-19861**

**PARTIAL GRANT OF EXEMPTION**

By letter dated December 6, 2004, Mr. Paulo C. Olenski, Certification Manager; Embraer Empresa Brasileira de Aeronáutica S.A. (Embraer); Av. Brigadeiro Faria Lima, 2170; 12227-901 – S. José dos Campos – SP; Brazil, petitioned for an exemption from the “no single failure” criterion 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 Embraer Model ERJ 190/CF34-10E airplanes, including the ERJ 190-100 and ERJ 190-200.

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

Section 25.901(c) which requires, in part, that “no single failure will jeopardize the safe operation of the airplane.”

**The petitioner’s supportive information:**

As required by 14 CFR §11.25, Embraer offers the following justification in support of its petition for exemption as well as substantiation as to how the proposed type design provides an acceptable level of safety and why granting the exemption will be in the public interest.

Embraer respectfully submits this Petition for a conditional exemption of its ERJ 190/CF34-10E aircraft from the no single failure requirements of 14 CFR §25.901(c) for certain extremely remote high thrust failure conditions. Currently, the ERJ 190/CF34-10E engine control system does not fully comply with the single failure criteria of

§25.901(c) for high thrust failure conditions, if the failure were to occur within a very narrow portion of the aircraft's flight envelope.

This conditional exemption proposal requires Embraer to demonstrate that the overall level of safety of the engine thrust control system of the ERJ 190/CF34-10E will not be less than that of the current transport category aircraft fleet and that, as required by 14 CFR §11.25, the granting of the conditional exemption is in the public interest.

Therefore, Embraer offers the following in support of its Petition for a conditional exemption:

1. All practicable actions (including maintenance practices and design/production processes) will be taken to minimize any adverse effect on safety arising from the granting of the exemption from §25.901(c) for the ERJ 190/CF34-10E. The only commercial transport accident that was the result of a high thrust failure occurred on the ground. Embraer will implement a safety control in the ERJ 190/CF34-10E engine control system that will automatically detect and prevent any hazard from high thrust failure that might occur while operating on the ground. For any potential failures that may occur in-flight, Embraer will show the risk for any such failure is no greater than the risk for other recently certified similar aircraft.

Specifically, Embraer submits that:

- a. The risk associated with this failure scenario is the same as the current average per flight hour for other existing comparable transport category aircraft, which is one per ten million aircraft operating hours.
  - b. Embraer will demonstrate that the ERJ 190/CF34-10E complies with 14 CFR §25.901(c) for any foreseeable uncontrollable high thrust failure conditions, except the extremely remote probability during certain portions of take-off and approach below 400 feet.
2. Additionally, the engine control in the ERJ 190/CF34-10E is similar to that in the ERJ 170/CF34-8 with respect to high thrust failure conditions. The CF34-8 engine control, currently installed in two different aircraft (ERJ170/CF34-8E and CRJ700/CF34-8C), has been found to have safety-focused design and production processes as well as established maintenance practices that have resulted in an excellent service record to date. No malfunction incident has been reported in the past 1,187,000 flight hours.
  3. Embraer will continuously assess the thrust control system of the ERJ 190/CF34-10E and correct any unsafe conditions identified, as required by the FAA's Thrust Control Malfunction (TCM) Airworthiness Program, as necessary.

## **The petitioner's Statement of Public Interest:**

The introduction and systematic use of regional jets, like the Embraer ERJ 190/CF34-10E, into air carrier service has benefited the American public by providing it with the low-cost ability to fly directly from origin to destination without having an additional stop in an airline hub. The Embraer ERJ 190/CF34-10E is designed with that need in mind. Denying this Petition for a conditional exemption and thereby restricting it from competing in this market would eliminate a source for the fastest growing form of airline travel and ultimately result in higher costs for the American traveling public. A denial of this Petition would drive up the acquisition cost of the aircraft and thus such costs would be passed onto consumers through higher airfares.

Critically, the aviation industry has not yet developed engine control designs that eliminate all possible thrust control malfunctions. This statement is equally true for Embraer's competitors. As such, the granting of this Petition would not adversely affect the safety of airline travel.

Further, a denial of this Petition would negatively impact American manufacturers involved in the production of the ERJ 190/CF34-10E. While the ERJ 190/CF34-10E is not manufactured in its entirety in the United States, a significant portion of the aircraft, including the engines, avionics, and interiors are manufactured by American companies. Denial of this Petition would result in the loss of revenue for the American suppliers and have an adverse impact on the American balance of trade, both of which are counter to the public interest.

Most importantly, the granting of this Petition for a conditional exemption would not result in any reduction in the level of safety of the ERJ 190/CF34-10E as compared to the current operational fleet of aircraft. In fact, the proposed ERJ 190/CF34-10E design will increase aircraft safety through the precautions Embraer will initiate as a result of the granting of this Petition. Embraer's implementation of an uncommanded overthrust protection for use while on the ground will mitigate the adverse effect of an already extremely remote failure. Therefore, in light of the very remote probability of the occurrence of an uncommanded high thrust failure, the implementation of certain safety mechanisms and because the current acceptable level of safety would be maintained, it is respectfully submitted that this Petition for a conditional exemption would not be adverse to the public interest in safe aircraft travel and that the granting of this Petition would benefit the American public through the growth of safer and less expensive air travel.

## **Notice and Public Procedure Provided**

A Notice of Petition for Exemption; Summary of Petition Received was published in the Federal Register on January 13, 2005. One comment was received. It expressed opposition to a grant of exemption but supplied no supporting information.

## **The Federal Aviation Administration's (FAA) analysis:**

### **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 or autothrottle). A subset of the resulting failure conditions may include actual thrust either increasing to higher than commanded levels and/or thrust 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.

The FAA estimates that over the last 20 years the average rate of occurrence for the uncontrollable high thrust failure condition on turboprop-powered large transport category airplanes has remained relatively constant at around one every 2.5 million flight hours. This estimate indicates 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, recent 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 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 will 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.

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. Such a request is what led Embraer to submit the subject 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.

### **Embraer Model ERJ 190 series airplanes and GE CF34-10E series engines**

The engine thrust control system for the GE CF34-10E series engines proposed to be installed on the Model ERJ 190 series airplane includes thrust control malfunction protection logic to mitigate uncontrollable high thrust conditions only on the ground. However, the petitioner has indicated that there are single failures in flight that can cause a CF34-10E engine to produce high thrust up to the level where the first independent limiter (governor) is encountered, while not responding to the throttle lever. Further, the petitioner has indicated that this circumstance may jeopardize the safe operation of the Model ERJ 190 airplane, if it occurs during certain conditions in the final approach and landing.

The petitioner intends to demonstrate that any combination of failures that could jeopardize safe operation complies with § 25.901(c) in that the combinations are not “probable combinations.”<sup>1</sup> Conversely, the petitioner does not intend to demonstrate that those single failures that 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 the single failures themselves must be assumed to occur regardless of their probability,<sup>2</sup> 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. Nonetheless, the proposed design is known to have single failures that will cause uncontrollable high thrust.

Uncontrollable high thrust under certain anticipated takeoff and landing conditions is expected to jeopardize the safe operation of the proposed airplane. Consequently, in order to certificate the installation of the GE CF34-10E series engines on the Model ERJ 190 series airplanes, the petitioner must either obtain this exemption or substantially modify the engine control system

---

<sup>1</sup> 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 terms of § 25.1309(b), “foreseeable” means that the subject failure conditions are “anticipated to occur” (i.e., they are not “extremely improbable”).

<sup>2</sup> While probability has been an acceptable means of supporting a finding that a particular “combination” of failures are 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 exempted by the rule itself.

design to mitigate the noted failure conditions in flight. As delineated in the petitioner's supporting information, the petitioner has concluded that the exemption is the option which best serves the public interest.

## **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.

### **Public interest**

The petitioner has committed to demonstrate that all practicable actions have been taken to minimize the adverse effect on safety associated with granting of the exemption from § 25.901(c) for the Model ERJ 190 series airplanes with GE CF34-10E series engines. Embraer has indicated that it intends to implement the thrust control malfunction protection logic on the ERJ 190 models equipped with CF34-10E engines to ensure that compliance with the "single failure" criterion of 14 CFR 25.901(c) is met for all uncontrollable high thrust failure conditions which occur on the ground. If the FAA is to certify the ERJ 190/ CF34-10E airplanes, making this commitment a condition of the exemption assures that granting the exemption will be in the public interest. That is, any risks associated with 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 that is "in the public interest." Furthermore, if bringing the airplane into compliance were 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.

### **Effect on safety**

The petitioner has committed to demonstrate that the exposures and failure rates of ERJ 190/ CF34-10E airplanes are such that the airplane should not exceed the known average risks per flight hour of comparable existing transport category airplanes. Making this commitment 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 decrease the average risk per flight hour 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 specter 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's "Thrust Control Malfunction Airworthiness Program." To date, corrective actions under 14 CFR part 39 have been considered warranted only when the uncorrected risks for a particular type design were considered significantly greater than the known average risks within the transport fleet. Since the conditions and limitations of this exemption require that the Embraer Model ERJ 190 series airplane with a CF34-10E engine be expected to have an uncontrollable high thrust failure rate over three times better than the current fleet average, the impact of adding the fleet hours of the Model ERJ 190 series airplane with CF34-10E series engines 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 inherently implies 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 worse problem than 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, Embraer Empresa Brasileira de Aeronáutica S.A. (Embraer) is granted an exemption from § 25.901(c) to the extent necessary to allow type certification of the Model ERJ 190 series airplanes with CF34-10E series engines and without an exact showing of compliance with the requirements of § 25.901(c) as they relate to single failures resulting in uncontrollable high thrust conditions. For the Model ERJ 190/CF34-10E airplanes, this exemption is subject to the following conditions and limitations:

1. Embraer 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. Embraer 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 ERJ 190 series

airplanes with GE CF34-10E series engines than those generally known to exist for comparable airplanes within the current transport fleet. 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 final approach/landing 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 Embraer Document (reference tbd) may endanger the safe operation of an airplane and hence operators are encouraged to report such failures in accordance with §§ 121.703 (c), 125.409 (c), and 135.415(c).**

In support of this “Note,” Embraer must develop and obtain FAA approval of the Embraer document referenced in the “Note” prior to customer delivery. 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.

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

Issued in Renton Washington on August 25, 2005.

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