Exemption No. 16780

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

In the matter of the petition of **Bombardier Aerospace** for an exemption from § 25.901(c) of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2016-2750**

GRANT OF EXEMPTION

By letters dated January 13, 2016, and April 4, 2016, Mr. Glenn Baxter, C Series Airworthiness Manager, Bombardier Aerospace, 400 Cote-Vertu Road West, Dorval, Quebec, H4S 1Y9, Canada, petitioned the Federal Aviation Administration (FAA) for an exemption from the requirements of § 25.901(c) of Title 14, Code of Federal Regulations (14 CFR). This exemption, if granted, would permit relief from full compliance with the regulation for Model BD-500-1A10 and BD-500-1A11 airplanes.

The petitioner requests relief from the following regulation:

> **Section 25.901(c)** – 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 supports its request with the following information:

This section quotes the relevant information from the petitioner's request, with minor edits for clarity. 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-2016-2750.

Description of Relief Sought

Bombardier Aerospace (Bombardier) respectfully requests a permanent exemption from 14 CFR 25.901(c) for a certain extremely improbable throttle quadrant assembly (TQA) failure that could contribute, under specific simultaneously converging conditions, to an engine uncontrolled high thrust (UHT) event under very limited and specific takeoff and

landing scenarios on the BD-500-1A10 and BD-500-1A11 airplanes (C Series CS100 and C Series CS300, respectively).

This exemption is requested for a permanent period after FAA type validation. Due to the small (single) number of failures within the TQA, the limited window of exposure, and the practicality of redesigning the TQA (which currently meets the industry norms), Bombardier believes permanent relief from § 25.901(c), relative to the TQA, is appropriate. Furthermore, Bombardier understands precedent exists with the FAA for this relief, most recently with FAA Exemption No. 10614.

Justification

Bombardier has shown in the position to FAA Issue Paper P-25 that the overall level of safety of the thrust control system of the C Series CS100 and CS300 airplanes will not be less than that of the current Bombardier transport category aircraft fleet. The Bombardier fleet of full authority digital electronic control (FADEC) equipped aircraft have more than 16 million aircraft flight hours. This fleet has never had a TQA failure leading to a UHT event. Full compliance with § 25.901(c) would require the introduction of novel design features to the BD-500-1A10 and BD-500-1A11 airplanes.

It is recognized that experience over the past few years has demonstrated that some design solutions can safely and reliably eliminate the possibility of a single failure or combination of failures leading to a UHT event. Bombardier has introduced a thrust control malfunction accommodation feature into the engine electronic control to address engine failures that may lead to a UHT event and will eliminate all noncompliant, uncontrollable, high-thrust failures, except for a very specific case related to the drive train failure of the TQA under a high-speed rejected takeoff (RTO) operation.

Introducing a more complex design into the TQA assembly with the intent of eliminating the single failure will introduce more components to the assembly, increasing the probability of failure and being counterproductive to both Bombardier's and the FAA's goal of continuous improvement in overall aircraft reliability and safety. Such design changes may minimize drive train failures but would not eliminate the more likely events of a jammed control(s) due to foreign objects, both within the control and externally from items on the flight deck.

Issue of Public Interest

A thrust control system design change that would keep the aircraft controllable for all UHT single system failures would require modifications to the current TQA. Implementing this redesign would prevent Bombardier from certifying the C Series CS100 and CS300 design in a timely and competitive schedule, putting it in an unfair disadvantage to its competitors and directly affecting its customers in the United States.

Additionally, requiring the BD-500-1A10 and BD-500-1A11 models to fully comply with this rule would adversely affect United States companies involved in the design and production of the aircraft.

Effect of the Exemption on Safety

As stated above and as previously demonstrated to the FAA by analysis, the risks due to UHT failure conditions on the BD-500-1A10 and BD-500-1A11 aircraft will not exceed those of the current Bombardier transport category aircraft fleet, nor the currently known and comparable existing transport category airplanes.

The conditions under which a UHT failure may jeopardize the safe operation of the airplane are limited to specific conditions during takeoff and landing scenarios. The majority of these scenarios are addressed by the engine thrust control malfunction accommodation feature. A UHT event due to a single failure in the TQA has a very low risk per flight hour, many orders of magnitude less than that accepted as extremely improbable. The Bombardier TQAs have never had a disconnect of the drive train between the control lever and the throttle position resolvers. Such a failure will be less than extremely remote.

The Bombardier assessment is that the TQA failure would only become a hazard when associated with a high speed RTO. The Bombardier assessment shows that an RTO is an independent event from the TQA failure. A high speed RTO not associated with another aircraft failure is remote (i.e., due to birds or aircraft failure to clear an active runway < 1E-05). Additionally, in the event of an occurrence, there is limited risk that any serious injury will result.

Conclusion & Request to Extend Privilege of Exemption Outside the United States

Bombardier believes that the above arguments favor a permanent exemption from § 25.901(c) for the TQA on the BD-500-1A10 and BD-500-1A11 (C Series 100 and C Series 300) airplanes. Additionally, Bombardier believes that any risks due to a UHT failure condition generated by the TQA single failure case on the subject airplanes will not exceed that of comparable existing transport category airplanes and that an exemption is in the public interest. Bombardier requests that the privileges of this exemption would apply outside the United States due to the transoceanic capability of the subject airplanes and the character of mission for many of our operators.

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 April 27, 2016 (81 FR 24933). No comments were received.

The FAA's analysis

Introduction

Bombardier is requesting an exemption from the requirements of § 25.901(c) as it applies to the "no single failure" provision for the throttle quadrant assembly (TQA). Bombardier acknowledges that there are single failures of the TQA that could result in UHT under certain conditions. They also state that the TQAs on other Bombardier airplanes are of similar design methodology and have not had a failure that resulted in UHT. Bombardier contends that a redesign to eliminate the TQA drive train failure would add complexity and result in a less-reliable design. Bombardier has provided design details to the FAA demonstrating that they have taken all practical measures to eliminate single failures that could result in UHT. Those measures include provisions to minimize the potential for internal and external debris as well as eliminating all single failures within the TQA, except for a failure of the drive train gears resulting in a disconnect with the throttle and potentially causing a UHT event.

Additional UHT Consideration

The FAA recently identified a condition in which transport airplanes could become uncontrollable during flare about 10 seconds before touchdown if there is a sufficiently strong crosswind in combination with a UHT failure and that this condition is endemic to the transport airplane fleet. Bombardier has demonstrated that the Model BD-500-1A10 and BD-500-1A11 airplanes remain controllable and comply with 25.901(c) in crosswinds up to 15 knots. Since Bombardier did not include crosswinds in excess of 15 knots in their assessment and the "no single failure" requirement of 25.901(c) requires applicants to consider operational and environmental factors that could intensify a failure, the FAA has determined that this scenario should also be included in this grant of exemption. As a result, this exemption also applies to UHT landing scenarios that when combined with crosswinds in excess of 15 knots, would jeopardize the safe operation of the airplane.

Public Interest and Effect on Safety

According to § 11.81, Bombardier must show that granting this request is in the public interest and will not adversely affect safety. If the FAA were to deny this petition, it would substantially delay delivery of these airplanes and put considerable schedule pressure on the development and certification of additional design changes which would not necessarily prove to be more reliable and would not have the service history that supports a substantially low failure rate. This would not only have adverse economic and logistical impacts for Bombardier, but would also affect United States companies involved in the design and production of the airplanes. Therefore, we conclude that granting this petition would be in the public interest.

Bombardier acknowledges in the petition that the Model BD-500-1A10 and BD-500-1A11 airplane type design currently proposed for certification will not fully comply with the "no single failure" provision of § 25.901(c) as it relates to certain UHT failure conditions. The investigation of a 1997 accident involving a Saudi Arabian Airlines Boeing 737-200 airplane

determined that this type of non-compliance had long been endemic in the state-of-the-art engine control architectures of most transport category airplanes. Until recently, most type certification programs have included some sort of exemption for UHT failure conditions. However, one of the conditions for granting each of those exemptions has been that the applicant takes all practicable actions to minimize the adverse effects on safety associated with granting the exemption.

The FAA has reviewed the Model BD-500-1A10 and BD-500-1A11 type design and acknowledges that Bombardier has taken all practicable actions to eliminate or further reduce the risks associated with this non-compliance. Specifically, thrust malfunction accommodation logic (i.e., logic that identifies and safely accommodates any sustained, substantial discrepancy between the actual and commanded thrust, as sensed and validated by the engine control) has been implemented for those applicable UHT scenarios. Such thrust malfunction accommodation logic incorporated into airplane type designs has proven to be practical and effective at eliminating most noncompliant UHT failures except for those associated with the airplane throttle system (e.g., stuck throttle or disagreement between the throttle input to the engine control and the actual throttle position).

While some recent airplane throttle system designs have managed to fully comply with § 25.901(c), this has not yet become the industry norm. The Bombardier TQA design includes redundant features intended to prevent a stuck throttle at the high power position. The TQA design also has robust features intended to prevent the introduction of foreign objects or debris into the TQA. Other than debris jamming the TQA, Bombardier has identified only one remaining single failure of the drive train gear that could result in a UHT event. Since the conditions of this exemption only allow a very low overall predicted UHT occurrence rate, the FAA has usually found it is not in the public interest to require these systems be redesigned.

The conditions under which a UHT 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. Bombardier will be required, by the conditions for granting this exemption, to demonstrate that the risks due to UHT 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 that all practical actions are taken to eliminate or further reduce 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.

This exemption allows a slightly greater hazard than full compliance with § 25.901(c) but given the fact that the per-flight-hour risks associated with this non-compliance are low and the conditions under which a UHT failure is limited to specific aborted takeoff, approach, and landing conditions and that if these scenarios occur, there is still a low probability that a serious injury will result. The limited exposure, in conjunction with the historically low occurrence rate, makes this a relatively low risk per flight hour. The FAA has determined that the proposed

exemption provides a level of safety equivalent to that of the existing fleet of similar transport airplanes. Therefore, we conclude that granting this petition would not adversely affect safety.

The FAA's decision

In consideration of the foregoing, I find that a 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, I grant Bombardier Aerospace an exemption from 14 CFR 25.901(c). I grant this exemption to the extent necessary to allow type certification of Model BD-500-1A10 and Model BD-500-1A11 airplanes without an exact showing of compliance with the "no single failure" requirement of § 25.901(c) relating to UHT from a single failure of the TQA and the previously-described landing scenarios combined with crosswinds in excess of 15 knots.

This exemption is subject to the following conditions and limitations:

1. For the Model BD-500-1A10 and BD-500-1A11 airplanes, Bombardier 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 exemption. These must include, but are not limited to, practical actions to eliminate or further reduce the risks by improving designs, training, procedures, and instructions for continued airworthiness (ICA).

2. For the Model BD-500-1A10 and BD-500-1A11 airplanes, Bombardier must demonstrate, in accordance with an FAA-approved Airworthiness Assessment and Risk Management Plan, that the risks associated with relieving the UHT failure condition from the "no single failure" requirement of § 25.901(c) are no greater than those currently known and accepted 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 UHT failure conditions in flight, except possibly during approach below 400 feet; and

    b. The expected frequency of the occurrence of a UHT failure condition is less than once per 10 million airplane flight hours.

3. The following "Note" will be added to the Model BD-500-1A10 and BD-500-1A11 type certificate 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 Bombardier Aerospace Document *[reference TBD]*, may endanger the safe operation of an airplane. Consequently, the FAA recommends that

operators be encouraged to report any such failures in accordance with Title 14, Code of Federal Regulations 121.703(c), 125.409(c), and 135.415(c).

4. In support of the "Note" in condition 3 above, Bombardier must develop the document referenced in condition 3 and obtain FAA approval prior to United States customer delivery of the BD-500-1A10 and BD-500-1A11 airplanes. That document will list the failures that can contribute to or cause a UHT failure condition covered under this exemption. This document will ultimately be made available as part of the ICA. Furthermore, for any airplane certificated under this exemption, failures of the type listed within that document must be promptly reported to the FAA. The reporting method and report timeliness requirements should be the same as those for reporting events under 14 CFR 21.3.

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

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Michael Kaszycki
Assistant Manager, Transport Airplane Directorate
Aircraft Certification Service