

### Electronic Flight Control System: Control Surface Awareness and Mode Annunciation

■ 1. In addition to the requirements of §§ 25.143, 25.671, and 25.672, the following requirements apply:

a. The system design must ensure that the flightcrew is made suitably aware whenever the primary control means nears the limit of control authority.

**Note:** The term “suitably aware” indicates annunciations provided to the flightcrew are appropriately balanced between nuisance and that necessary for crew awareness.

b. If the design of the flight control system has multiple modes of operation, a means must be provided to indicate to the flightcrew any mode that significantly changes or degrades the normal handling or operational characteristics of the airplane.

Issued in Renton, Washington, on April 22, 2014.

**Jeffrey E. Duven,**

*Manager, Transport Airplane Directorate, Aircraft Certification Service.*

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## DEPARTMENT OF TRANSPORTATION

### Federal Aviation Administration

#### 14 CFR Part 25

[Docket No. FAA-2013-1039; Notice No. 25-547-SC]

#### Special Conditions: Bombardier Aerospace, Models BD-500-1A10 and BD-500-1A11 Series Airplanes; Flight Envelope Protection: Normal Load Factor (g) Limiting

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Final Special Conditions.

**SUMMARY:** These special conditions are issued for the Bombardier Aerospace Models BD-500-1A10 and BD-500-1A11 series airplanes. These airplanes will have a novel or unusual design feature associated with an electronic flight control system that prevents the pilot from inadvertently or intentionally exceeding the positive or negative airplane limit load factor. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

**DATES:** *Effective Date:* July 7, 2014.

**FOR FURTHER INFORMATION CONTACT:** Joe Jacobsen, FAA, Airplane and Flight Crew Interface Branch, ANM-111, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW., Renton, Washington 98057-3356; telephone 425-227-2011; facsimile 425-227-1149.

#### SUPPLEMENTARY INFORMATION:

##### Background

On December 10, 2009, Bombardier Aerospace applied for a type certificate for their new Models BD-500-1A10 and BD-500-1A11 series airplanes (hereafter collectively referred to as “CSeries”). The CSeries airplanes are swept-wing monoplanes with an aluminum alloy fuselage sized for 5-abreast seating. Passenger capacity is designated as 110 for the Model BD-500-1A10 and 125 for the Model BD-500-1A11. Maximum takeoff weight is 131,000 pounds for the Model BD-500-1A10 and 144,000 pounds for the Model BD-500-1A11.

The design of the electronic flight control system for the CSeries airplanes incorporates normal load factor limiting on a full time basis that prevents the flightcrew from inadvertently or intentionally exceeding the positive or negative airplane limit load factor. This feature is considered novel and unusual in that the current regulations do not provide standards for maneuverability and controllability evaluations for such systems.

##### Type Certification Basis

Under the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.17, Bombardier Aerospace must show that the CSeries airplanes meet the applicable provisions of part 25 as amended by Amendments 25-1 through 25-129 thereto.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for the CSeries airplanes because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the type certificate for that model be amended later to include any other model that incorporates the same or similar novel or unusual design feature, the special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, the CSeries airplanes must comply with the fuel vent and exhaust emission requirements of 14 CFR part 34 and the noise certification

requirements of 14 CFR part 36, and the FAA must issue a finding of regulatory adequacy under § 611 of Public Law 92-574, the “Noise Control Act of 1972.”

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type-certification basis under § 21.17(a)(2).

##### Novel or Unusual Design Features

The CSeries airplanes will use a fly-by-wire electronic flight control system (EFCS). This system provides an electronic interface between the pilot’s flight controls and the flight control surfaces for both normal and failure states; and it generates the actual surface commands that provide for stability augmentation and control about all three airplane axes.

The design of the EFCS incorporates the following novel or unusual design feature: Normal load factor limiting on a full-time basis that will prevent the flight crew from inadvertently or intentionally exceeding the positive or negative airplane limit load factor. This feature is considered novel or unusual because the current regulations do not provide standards for maneuverability and controllability evaluations for such systems. Therefore, special conditions are needed to ensure adequate maneuverability and controllability when using this design feature.

##### Discussion

Title 14, Code of Federal Regulations, part 25 does not specify requirements or policy for demonstrating maneuver control that impose any handling qualities requirements beyond the design limit structural loads. Nevertheless, some pilots have become accustomed to the availability of this excess maneuver capacity in case of extreme emergency such as upset recoveries or collision avoidance.

As with previous fly-by-wire airplanes, the FAA has no regulatory or safety reason to prohibit a design for an electronic flight control system with load factor limiting. It is possible that pilots accustomed to this feature feel more freedom in commanding full-stick displacement maneuvers because of the following:

- Knowledge that the limit system will protect the structure,
- Low stick force/displacement gradients,
- Smooth transition from pilot elevator control to limit control.

These special conditions will ensure adequate maneuverability and controllability when using this design feature.

The normal load factor limit on the C Series airplanes is unique in that traditional airplanes with conventional flight control systems (mechanical linkages) are limited in the pitch axis only by the elevator surface area and deflection limit. The elevator control power is normally derived for adequate controllability and maneuverability at the most critical longitudinal pitching moment. The result is that traditional airplanes have a significant portion of the flight envelope wherein maneuverability in excess of limit structural design values is possible.

These special conditions for the C Series airplanes supplement the applicable regulations, including § 25.143, to accommodate the unique features of the flight envelope limiting systems, and establish an equivalent level of safety to the existing regulations.

#### Discussion of Comments

Notice of proposed special conditions No. 25-13-38-SC for the Bombardier C Series airplanes was published in the **Federal Register** on December 11, 2013 (78 FR 75285). No comments were received, and the special conditions are adopted as proposed.

#### Applicability

As discussed above, these special conditions are applicable to the Models BD-500-1A10 and BD-500-1A11 series airplanes. Should Bombardier Aerospace apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, the special conditions would apply to that model as well.

#### Conclusion

This action affects only certain novel or unusual design features on two model series of airplanes. It is not a rule of general applicability.

#### List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

**Authority:** 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

#### The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for the Bombardier Aerospace Models BD-500-1A10 and BD-500-1A11 series airplanes.

#### Flight Envelope Protection: Normal Load Factor (g) Limiting

■ 1. To meet the intent of adequate maneuverability and controllability required by § 25.143(a), and in addition to the requirements of § 25.143(a) and in the absence of other limiting factors, the following special conditions based on § 25.333(b) apply:

a. The positive limiting load factor must not be less than:

(1) 2.5g for the normal state of the electronic flight control system with the high lift devices retracted.

(2) 2.0g for the normal state of the electronic flight control system with the high lift devices extended.

b. The negative limiting load factor must be equal to or more negative than:

(1) Minus 1.0g for the normal state of the electronic flight control system with the high lift devices retracted.

(2) 0.0g for the normal state of the electronic flight control system with high lift devices extended.

c. Maximum reachable positive load factor wings level may be limited by the characteristics of the electronic flight control system or flight envelope protections (other than load factor protection) provided that:

(1) The required values are readily achievable in turns, and

(2) That wings level pitch up is satisfactory.

d. Maximum achievable negative load factor may be limited by the characteristics of the electronic flight control system or flight envelope protections (other than load factor protection) provided that:

(1) Pitch down responsiveness is satisfactory, and

(2) From level flight, 0g is readily achievable or alternatively, a satisfactory trajectory change is readily achievable at operational speeds. For the FAA to consider a trajectory change as satisfactory, the applicant should propose and justify a pitch rate that provides sufficient maneuvering capability in the most critical scenarios.

e. Compliance demonstration with the above requirements may be performed without ice accretion on the airframe.

These special conditions do not impose an upper bound for the normal load factor limit, nor do they require that the limit exist. If the limit is set at a value beyond the structural design limit maneuvering load factor “n” of §§ 25.333(b) and 25.337(b) and (c), there should be a very obvious positive tactile feel built into the controller so that it serves as a deterrent to inadvertently exceeding the structural limit.

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#### DEPARTMENT OF TRANSPORTATION

#### Federal Aviation Administration

#### 14 CFR Part 25

[Docket No. FAA-2013-1040; Notice No. 25-548-SC]

#### Special Conditions: Bombardier Aerospace, Models BD-500-1A10 and BD-500-1A11 Series Airplanes; Flight Envelope Protection: General Limiting Requirements

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Final Special Conditions.

**SUMMARY:** These special conditions are issued for the Bombardier Aerospace Models BD-500-1A10 and BD-500-1A11 series airplanes. These airplanes will have a novel or unusual design feature associated with a new control architecture and a full digital flight control system that provides flight envelope protections. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

**DATES:** *Effective Date:* July 7, 2014.

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