[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

Docket No. FAA-2015-2884; Special Conditions No. 25-595-SC

Special Conditions: Embraer Model EMB-545 Airplanes; Seats with Inflatable Lap Belts

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions; request for comments.

SUMMARY: These special conditions are issued for Embraer Model EMB-545 airplanes. These airplanes will have a novel or unusual design feature associated with seats with inflatable lap belts. 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: The effective date of these special conditions is **[INSERT DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. We must receive your comments by **[INSERT DATE 45 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]**.

ADDRESSES: Send comments identified by docket number FAA-2015-2884 using any of the following methods:

- *Federal eRegulations Portal:* Go to http://www.regulations.gov/ and follow the online instructions for sending your comments electronically.
- *Mail:* Send comments to Docket Operations, M-30, U.S. Department of Transportation (DOT), 1200 New Jersey Avenue, SE., Room W12-140, West Building Ground Floor, Washington, DC, 20590-0001.
- *Hand Delivery or Courier:* Take comments to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- *Fax:* Fax comments to Docket Operations at 202-493-2251.

Privacy: The FAA will post all comments it receives, without change, to http://www.regulations.gov/, including any personal information the commenter provides. Using the search function of the docket Web site, anyone can find and read the electronic form of all comments received into any FAA docket, including the name of the individual sending the comment (or signing the comment for an association, business, labor union, etc.). DOT's complete Privacy Act Statement can be found in the **Federal Register** published on April 11, 2000 (65 FR 19477-19478), as well as at http://DocketsInfo.dot.gov/.

Docket: Background documents or comments received may be read at http://www.regulations.gov/ at any time. Follow the online instructions for accessing the docket or go to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Jayson Claar, FAA, Airframe and Cabin Safety Branch, ANM-115, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue, SW., Renton, Washington, 98057-3356; telephone (425) 227-2194, facsimile (425) 227-1232.

SUPPLEMENTARY INFORMATION:

The FAA has determined that notice of, and opportunity for, prior public comment on these special conditions are impracticable because these procedures would significantly delay issuance of the design approval and thus delivery of the affected airplane.

In addition, the substance of these special conditions has been subject to the public-comment process in several prior instances with no substantive comments received. The FAA therefore finds that good cause exists for making these special conditions effective upon issuance.

Comments Invited

We invite interested people to take part in this rulemaking by sending written comments, data, or views. The most helpful comments reference a specific portion of the special conditions, explain the reason for any recommended change, and include supporting data.

We will consider all comments we receive by the closing date for comments. We may change these special conditions based on the comments we receive.

Background

On October 14, 2010, Embraer S.A. applied for an amendment to Type Certificate No. TC00062IB to include the new Embraer Model EMB-545 airplane. These special conditions allow installation of inflatable lap belts for head-injury protection on certain seats in Embraer Model EMB-545 airplanes.

The Embraer Model EMB-545 airplane is a derivative of the Model EMB-550 airplane currently approved under Type Certificate No. TC00062IB. As compared to the Model EMB-550, the Model EMB-545 fuselage is one meter shorter; the section ahead of the wing is 0.65 meters shorter; and the section aft of the wing is 0.40 meters shorter.

The fuselage length difference is in the pressurized section. The Model EMB-545 airplane is designed for an eight-passenger configuration and a maximum of nine passengers (including lavatory seat). Like the Model EMB-550, the Model EMB-545 airplane primary structure is aluminum. Materials other than aluminum will be used in areas with unique structural requirements. Advanced composites will be largely employed on the high-lift devices (two flaps), spoilers (three panels), and control surfaces (aileron). A winglet will be attached to each wing tip to further increase airplane aerodynamic efficiency. The empennage will be a swept T-tail composed of advanced composite material with metallic attachment fittings. The rudder and elevators also will be composed of composite material.

Two Honeywell HTF7500-E medium-bypass-ratio turbofan engines, mounted on aft-fuselage pylons, will power the Model EMB-545 airplane. Each engine will produce approximately 6,540 lbs. of thrust for normal takeoff. However, because the Model EMB-545 is smaller and lighter, software will regulate the thrust. The primary flight-control systems (elevators, ailerons, rudder, and multi-function spoilers) will be electronically controlled and powered by electrohydraulic servoactuators using digital fly-by-wire (FBW) technology. The FBW flight controls will receive commands directly from the cockpit dual sidesticks and conventional rudder pedals.

Occupants must be protected from head injury, as required by § 25.785, either by eliminating any injurious object within the striking radius of the head, or by installing padding. Traditionally, this has

required either a setback of 35 inches from any bulkhead or other rigid interior feature or, where not practical, the installation of specified types of padding. The relative effectiveness of these established means of injury protection was not quantified. With the adoption of Amendment 25-64 to part 25, specifically § 25.562, a new standard was created that quantifies required head-injury protection.

Each seat-type design approved for crew or passenger occupancy during takeoff and landing, as required by § 25.562, must successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar type seat. In particular, the regulations require that persons not suffer serious head injury under the conditions specified in the tests, and that protection must be provided, or the seat be designed, so that head impact does not exceed a HIC value of 1,000 units. While the test conditions described for HIC are detailed and specific, it is the intent of the requirement that an adequate level of head-injury protection be provided for passengers in a severe crash.

Because §§ 25.562 and 25.785 and associated guidance do not adequately address seats with inflatable lap belts, the FAA recognizes that appropriate pass/fail criteria need to be developed that fully address the safety concerns specific to occupants of these seats.

Type Certification Basis

Under the provisions of 14 CFR 21.101, Embraer must show that the Model EMB-545 airplane meets the applicable provisions of the regulations listed in Type Certificate No. TC00062IB, or the applicable regulations in effect on the date of application for the change, except for earlier amendments as agreed upon by the FAA. The regulations listed in the type certificate are commonly referred to as the "original type certification basis." The regulations incorporated by reference in Type Certificate No. TC00062IB are as follows:

14 CFR part 25, effective February 1, 1965, including Amendments 25-1 through 25-129, in their entirety. In addition, the certification basis includes certain special conditions, exemptions, or later amended sections of the applicable part that are not relevant to these special conditions.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for Embraer Model EMB-545 airplanes because of a novel or unusual design feature, special conditions are prescribed under § 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 novel or unusual design feature, or should any other model already included on the same type certificate be modified to incorporate the same novel or unusual design feature, these special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, Embraer Model EMB-545 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.

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 § 21.101.

Novel or Unusual Design Features

Embraer Model EMB-545 airplanes will incorporate the following novel or unusual design feature: seats with inflatable lap belts.

Discussion

The inflatable lap belt has two potential advantages over other means of head-impact protection. First, it can provide significantly greater protection than would be expected with energy-

absorbing pads, and second, it can provide essentially equivalent protection for occupants of all stature. These are significant advantages from a safety standpoint, because such devices will likely provide a level of safety that exceeds the minimum standards of part 25. Conversely, inflatable lap belts in general are active systems and must be relied upon to activate properly when needed, as opposed to an energy-absorbing pad or upper torso restraint that is passive and always available. Therefore, the potential advantages must be balanced against this and other potential disadvantages to develop standards for this design feature.

The FAA has considered the installation of inflatable lap belts to have two primary safety concerns: first, that they perform properly under foreseeable operating conditions; and second, that they do not perform in a manner or at such times as would constitute a hazard to the airplane or occupants. This latter point has the potential to be the more rigorous of the requirements, owing to the active nature of the system.

The inflatable lap belt will rely on electronic sensors for signaling, and will employ an automatic inflation mechanism for activation, so that it is available when needed. These same devices could be susceptible to inadvertent activation, causing deployment in a potentially unsafe manner. The consequences of such deployment must be considered in establishing the reliability of the system. Embraer must substantiate that the effects of an inadvertent deployment in flight are either not a hazard to the airplane, or that such deployment is an extremely improbable occurrence (less than 10^{-9} per flight hour). The effect of an inadvertent deployment on a passenger or crewmember that might be positioned close to the inflatable lap belt should also be considered. The person could be either standing or sitting. A minimum reliability level will have to be established for this case, depending upon the consequences, even if the effect on the airplane is negligible.

The potential for an inadvertent deployment could be increased as a result of conditions in service. The installation must take into account wear and tear so that the likelihood of an inadvertent deployment is not increased to an unacceptable level. In this context, an appropriate inspection interval and self-test capability are considered necessary. Other outside influences are lightning and high-intensity radiated fields (HIRF). Existing regulations regarding lightning, § 25.1316, and HIRF, § 25.1317, are applicable. For compliance with those conditions, if inadvertent deployment could cause a hazard to the airplane, the inflatable lap belt is considered a critical system; if inadvertent deployment could cause injuries to persons, the inflatable lap belt should be considered an essential system. Finally, the inflatable lap-belt installation should be protected from the effects of fire, so that an additional hazard is not created by, for example, a rupture of a pyrotechnic squib.

To function as an effective safety system, the inflatable lap belt must function properly and must not introduce any additional hazards to occupants as a result of its functioning. The inflatable lap belt differs variously from traditional occupant-protection systems and requires special conditions to ensure adequate performance.

Because the inflatable lap belt is essentially a single-use device, it could potentially deploy under crash conditions that are not sufficiently severe as to require head-injury protection from the inflatable lap belt. And because an actual crash is frequently composed of a series of impacts before the airplane comes to rest, this could render the inflatable lap belt useless if a larger impact follows the initial impact. This situation does not exist with energy-absorbing pads or upper-torso restraints, which tend to provide continuous protection regardless of severity or number of impacts in a crash event. Therefore, the inflatable lap-belt installation should be such that the inflatable lap belt will provide protection when it is required, by not expending its protection during a less-severe impact. Also, it is possible to have

several large impact events during the course of a crash, but there will be no requirement for the inflatable lap belt to provide protection for multiple impacts.

Given that each occupant's restraint system provides protection for that occupant only, the installation must address unoccupied seats. It will be necessary to show that the required protection is provided for each occupant regardless of the number of occupied seats, and that unoccupied seats may have lap belts that are active.

The inflatable lap belt should be effective for a wide range of occupants. The FAA has historically considered the range from the 5th percentile female to the 95th percentile male as the range of occupants that must be taken into account. In this case, the FAA is proposing consideration of a broader range of occupants due to the nature of the lap-belt installation and its close proximity to the occupant. In a similar vein, these persons could have assumed the brace position for those accidents where an impact is anticipated. Test data indicate that occupants in the brace position do not require supplemental protection, so it would not be necessary to show that the inflatable lap belt will enhance the brace position. However, the inflatable lap belt must not introduce a hazard when it is deployed into a seated, braced occupant.

Another area of concern is the use of seats so equipped by children, whether they are lap-held, sitting in approved child-safety seats, or occupying the seat directly. Although specifically prohibited by FAA operating regulations, the use of the supplementary loop belt ("belly belt") may be required by other civil aviation authorities, and should also be considered with the end goal of meeting those regulations. Similarly, if the seat is occupied by a pregnant woman, the installation needs to address such usage, either by demonstrating that it will function properly, or by adding appropriate limitation on usage.

The inflatable lap belt will be electrically powered. Likewise, the system could possibly fail due to a separation in the fuselage. Because this system is intended as crash/post-crash protection means, failure due to fuselage separation is not acceptable. As with emergency lighting, the restraint system should function properly if such a separation occurs at any point in the fuselage.

Because the inflatable lap belt is likely to have a large volume displacement, the inflated bag could potentially impede egress of passengers. However, the lap-belt bag deflates to absorb energy, so it is likely that an inflatable lap belt would be deflated by the time passengers begin to leave their seats. Nonetheless, it is appropriate to specify a time interval after which the inflatable lap belt may not impede rapid egress. The maximum time allowed for an exit to open fully after actuation is 10 seconds, according to § 25.809(b)(2). Therefore, the FAA has established 10 seconds as the time interval that the inflatable lap belt must not impede rapid egress from the seat after it is deployed. In actuality, it is unlikely that a flight attendant would prepare an exit this quickly in an accident severe enough to warrant deployment of the inflatable lap belt. The inflatable lap belt will likely deflate much more quickly than 10 seconds.

This potential impediment to rapid egress is even more critical at the seats installed in the emergency-exit rows. Installation of inflatable restraints at the Type III exit rows presents different egress concerns as compared with front-row seats. However, the need to address egress is already part of the special conditions, so there is no change to the special conditions at this time. As noted below, the method of compliance with the special conditions may involve specific considerations when an inflatable restraint is installed at Type III exits. Section 25.813 clearly requires access to the exit from the main aisle in the form of an unobstructed passageway, and no interference in opening the exit. The restraint system must not create an impediment to the access to, and the opening of, the exit. These lap belts

should be evaluated in the exit row under existing regulations (§§ 25.809 and 25.813) and guidance material. The inflatable lap belts must also be evaluated in post-crash conditions, and should be evaluated using representative restraint systems in the bag-deployed condition.

This evaluation would include reviewing the access to, and opening of, the exit, specifically for obstructions in the egress path; and any interferences in opening the exit. Each unique interior configuration must be considered, e.g., passageway width, single or dual passageways with outboard seat removed, etc. If the restraint creates any obstruction or interference, it is likely that it could impede rapid egress from the airplane. In some cases, the passenger is the one who will open the exit, such as a Type III over-wing hatch. Project-specific means-of-compliance guidance is likely necessary if these restraint systems are installed at the Type III exit rows.

Note that the special conditions are applicable to the inflatable lap-belt system as installed. The special conditions are not an installation approval. Therefore, while the special conditions relate to each such system installed, the overall installation approval is separate, and must consider the combined effects of all such systems installed.

Embraer will install inflatable lap belts, a novel design feature, on certain seats of Model EMB-545 airplanes, to reduce the potential for head injury if an accident occurs. The inflatable lap belt works similar to an automotive inflatable air bag, except that the air bag in the Embraer design is integrated into the lap belt of the restraint system.

The performance criteria for head-injury protection in objective terms is stated in § 25.562. However, none of these criteria are adequate to address the specific issues raised concerning seats with inflatable lap belts. The FAA has therefore determined that, in addition to the requirements of part 25,

special conditions are needed to address requirements particular to the installation of seats with inflatable lap belts.

Accordingly, in addition to the passenger-injury criteria specified in § 25.785, these special conditions are proposed for Embraer Model EMB-545 airplanes equipped with inflatable lap belts. Other conditions may be developed, as needed, based on further FAA review and discussions with the manufacturer and civil-aviation authorities.

For a passenger-safety system, the inflatable lap belt is unique in that it is both an active and entirely autonomous device. While the automotive industry has good experience with inflatable air bags, the conditions of use and reliance on the inflatable lap belt as the sole means of injury protection are quite different. In automobile installations, the air bag is a supplemental system and works in conjunction with an upper-torso restraint. In addition, the crash event is more definable and typically of shorter duration, which can simplify the activation logic. The airplane-operating environment is also quite different from automobiles and includes the potential for greater wear and tear, and unanticipated abuse conditions (due to galley loading, passenger baggage, etc.). Airplanes also operate where exposure to HIRF could affect the lap-belt activation system.

Part I of Appendix F to part 25 specifies the flammability requirements for interior materials and components. There is no reference to inflatable restraint systems in Appendix F, because such devices did not exist at the time the flammability requirements were written. The existing requirements are based on material types as well as use, and have been specified in light of state-of-the-art materials available to perform a given function. Without a specific reference, the default requirement would apply to the type of material used in making the inflatable restraint, which is a fabric in this case. However, in writing special conditions, the FAA must also consider the use of the material, and whether the default

requirement is appropriate. In this case, the specialized function of the inflatable restraint means that highly specialized materials are needed. The standard normally applied to fabrics is a 12-second vertical ignition test. However, materials that meet this standard do not perform adequately as inflatable restraints. Because the safety benefit of the inflatable restraint is significant, the flammability standard appropriate for these devices should not screen out suitable materials and thereby effectively eliminate the use of inflatable restraints. The FAA must establish a balance between the safety benefit of the inflatable restraint and its flammability performance. Presently, the 2.5-inch-per-minute horizontal test is considered to provide that balance. As the state-of-the-art in materials progresses (which is expected), the FAA may change this standard in subsequent special conditions to account for improved materials.

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.

Applicability

These special conditions are applicable to Embraer Model EMB-545 airplanes. Should Embraer apply at a later date for a change to the type certificates to include another model that incorporates the same novel or unusual design feature, or should any other model already included on the same type certificate be modified to incorporate the same novel or unusual design feature, these special conditions would apply to the other model as well.

Conclusion

This action affects only certain novel or unusual design features on Embraer Model EMB-545 airplanes. It is not a rule of general applicability, and it affects only Embraer Model EMB-545 airplanes listed on amended Type Certificate No. TC00062IB.

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 Embraer Model EMB-545 airplanes with inflatable lap belts installed.

1. The inflatable lap belt must be shown to deploy and provide protection under crash conditions where it is necessary to prevent serious head injury. The means of protection must take into consideration a range of stature from a two-year-old child to a 95th percentile male. The inflatable lap belt must provide a consistent approach to energy absorption throughout that range of occupants. In addition, the following situations must be considered.

   The seat occupant is:

   - holding an infant
   - a child in a child-restraint device
   - a child not using a child-restraint device
   - a pregnant woman

2. The inflatable lap belt must provide adequate protection for each occupant regardless of the number of occupants of the seat assembly, considering that unoccupied seats may have an active airbag system in the lap belt.

3. The design must prevent the inflatable lap belt from being either incorrectly buckled or incorrectly installed such that the inflatable lap belt would not properly deploy. Alternatively, it must be shown that such deployment is not hazardous to the occupant, and will provide the required head-injury protection.
4. The inflatable lap-belt system must be shown not to be susceptible to inadvertent deployment as a result of wear and tear, or inertial loads resulting from in-flight or ground maneuvers (including gusts and hard landings), likely to be experienced in service.
5. Deployment of the inflatable lap belt must not introduce injury mechanisms to the seated occupant, nor result in injuries that could impede rapid egress. This assessment should include an occupant who is in the brace position when it deploys, and an occupant whose inflatable lap belt is loosely fastened.
6. An inadvertent deployment that could cause injury to a standing or sitting person must be shown to be improbable.
7. It must be shown that inadvertent deployment of the airbag system in the lap belt, during the most critical part of the flight, either will not cause a hazard to the airplane or its occupants, or meets the requirement of § 25.1309(b).
8. The inflatable lap belt must be shown to not impede rapid egress of occupants 10 seconds after its deployment.
9. The inflatable lap-belt system must be protected from lightning and HIRF. The threats specified in existing regulations regarding lightning, § 25.1316, and HIRF, § 25.1317, are incorporated by reference for the purpose of measuring lightning and HIRF protection. For the purposes of complying with HIRF requirements, the inflatable lap-belt system is considered a "critical system" if

its deployment could have a hazardous effect on the airplane; otherwise it is considered an "essential" system.

10. The inflatable lap belt must function properly after loss of normal airplane electrical power, and after a transverse separation of the fuselage at the most critical location. A separation at the location of the lap belt does not have to be considered.
11. The inflatable lap belt must be shown to not release hazardous quantities of gas or particulate matter into the cabin.
12. The inflatable lap-belt installation must be protected from the effects of fire such that no hazard to occupants will result.
13. A means must be available for a crewmember to verify the integrity of the inflatable-lap-belt-activation system prior to each flight, or it must be demonstrated to reliably operate between inspection intervals.
14. The inflatable material may not have an average burn rate of greater than 2.5 inches per minute when tested using the horizontal-flammability test as defined in 14 CFR part 25, Appendix F, Part I(b)(5).

15. The airbag system in the lap belt, once deployed, must not adversely affect the emergency-lighting system (i.e., block floor-proximity lights to the extent that the lights no longer meet their intended function).

Issued in Renton, Washington, on September 2, 2015.

/s/

Jeffrey E. Duven
Manager, Transport Airplane Directorate
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