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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA–2013–0384; Special Conditions No. 25–495–SC]

Special Conditions: Embraer, S.A., Model EMB–550 Airplane; Side-Facing Seats; Installation of Airbag Systems in Shoulder Belts

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are issued for the Embraer S.A. Model EMB–550 airplane. This airplane will have a novel or unusual design feature associated with multiple-place and single-place side-facing seats and the installation of airbag systems in the shoulder 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: *Effective Date:* September 16, 2013.

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:

Background

On May 14, 2009, Embraer S.A. applied for a type certificate for its new Model EMB–550 airplane. The Model EMB–550 airplane is the first of a new family of jet airplanes designed for corporate flight, fractional, charter, and private owner operations. The airplane has a conventional configuration with low wing and T-tail empennage. The primary structure is metal with composite empennage and control surfaces. The Model EMB–550 airplane is designed for 8 passengers, with a maximum of 12 passengers. It is equipped with two Honeywell HTF7500–E medium bypass ratio turbofan engines mounted on aft fuselage pylons. Each engine produces approximately 6,540 pounds (lbs) of thrust for normal takeoff. The primary flight controls consist of hydraulically powered fly-by-wire elevators, aileron and rudder, controlled by the pilot or copilot sidestick.

The Model EMB–550 airplane has interior configurations that include multiple-place side-facing seats and single-place side-facing seats (both referred to as side-facing seats) that include airbag systems in the shoulder belts for these seats. Existing regulations do not provide adequate or appropriate safety standards for occupants of side-facing seats. Also, existing regulations do not provide adequate or appropriate safety standards for the addition of airbag systems in the shoulder belt of side-facing seats. These special conditions address both issues.

Type Certification Basis

Under the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.17, Embraer S.A. must show that the Model EMB–550 airplane meets the applicable provisions of part 25, as amended by Amendments 25–1 through 25–127 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 Embraer S.A. Model EMB–550 airplane 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 Embraer S.A. Model EMB–550 airplane 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 Embraer S.A. Model EMB–550 airplane will incorporate the following novel or unusual design features: side-facing seats with airbag systems in the shoulder belts.

The Model EMB–550 airplane will have interior configurations with multiple-place side-facing seats and single-place side-facing seats that include airbag systems in the shoulder belts. Side-facing seats are considered a novel design for transport category airplanes that include Amendment 25–64 in their certification basis and were not anticipated when those airworthiness standards were issued. Therefore, the existing regulations do not provide adequate or appropriate safety standards for occupants of side-facing seats. The airbag systems in the shoulder belts are designed to limit occupant forward excursion in the event of an accident. Using airbag systems in the shoulder belts is novel for commercial aviation.

Discussion

The FAA has been conducting research to develop an acceptable method of compliance with Title 14, Code of Federal Regulations (14 CFR) 25.785(b) for side-facing seat installations. That research has identified additional injury considerations and evaluation criteria. See published report DOT/FAA/AR–09/41, July 2011.

Before this research, the FAA had been granting exemptions for the multiple-place side-facing seat installations since an adequate method of compliance was not available to produce an equivalent level of safety to that level of safety provided for the forward- and aft-facing seats. These

exemptions were subject to many conditions that reflected the injury evaluation criteria and mitigation strategies available at the time of the exemption issuance. The FAA has now developed a methodology to address all fully side-facing seats (i.e., seats oriented in the aircraft with the occupant facing 90 degrees to the direction of aircraft travel) and is documenting those requirements in these special conditions. Some of the previous conditions issued for exemptions are still relevant and are included in these new special conditions. However, many of the conditions for exemption have been replaced by different criteria that reflect current research findings.

The FAA had been issuing special conditions to address single-place side-facing seats; however, application of the current research findings has allowed issuing special conditions that are applicable to all fully side-facing seats, both multiple-place and single-place.

Neck-injury evaluation methods applicable to the most common side-facing seat configurations were identified during recent FAA research. The scope of that research, however, did not include deriving specific injury criteria for all possible loading scenarios that could occur to occupants of fully side-facing seats. To limit the injury risk in those cases, these special conditions provide conservative injury evaluation means that are derived from past practice and applicable scientific literature.

Serious leg injuries, such as femur fractures, can occur in aviation side-facing seats that could threaten the occupants' lives directly or reduce their ability to evacuate. Limiting upper-leg axial rotation to a conservative limit of 35 degrees (approximately the 50 percentile range of motion) should also limit the risk of serious leg injuries. It is believed that the angle of rotation can be determined by observing lower-leg flailing in typical high-speed video of the dynamic tests. This requirement complies with the intent of the § 25.562 (b)(6) injury criteria in preventing serious leg injury.

The requirement to provide support for the pelvis, upper arm, chest, and head contained in the previous special conditions for single-place side-facing seats, has been replaced in the new special conditions applicable to all fully side-facing seats with requirements for neck-injury evaluation, leg-flailing limits, pelvis-excursion limits, head-excursion limits, and torso lateral-bending limits that directly assess the effectiveness of the support provided by the seat and restraint system.

To protect occupants in aft-facing seats, those seats must have sufficient height and stiffness to support their heads and spines. Providing this support is intended to reduce spinal injuries when occupant inertial forces cause their heads and spines to load against the seat backs. If, during a side-facing-seat dynamic test, the flailing of the occupants causes their heads to translate beyond the planes of the seat backs, then this lack of support would not comply with the intent of the requirement to prevent spine injuries and would not provide the same level of safety afforded occupants of forward- and aft-facing seats.

Results from tests that produced lateral flailing over an armrest indicate that serious injuries, including spinal fractures, would likely occur. While no criteria currently relates the amount of lateral flail to a specific risk of injury, if lateral flexion is limited to the normal static range of motion, then the risk of injury should be low. This range of motion is approximately 40 degrees from the upright position. Ensuring that lateral flexion does not create a significant injury risk is consistent with the goal of providing an equivalent level of safety to that provided by forward- or aft-facing seats, because that type of articulation of those seats does not occur during forward impacts.

Section 25.562 requires that the restraints remain on the shoulders and pelvises of the occupants during impact. Advisory Circular (AC) 25.562–1B, *Dynamic Evaluation of Seat Restraint Systems and Occupant Protection on Transport Airplanes,* dated January 10, 2006, clarifies this requirement by stating that restraints must remain on the shoulders and pelvises when loaded by the occupants. This criterion is necessary to protect the occupants from serious injuries that could be caused by lap-belt contact forces applied to soft tissue or by ineffectively restraining the upper torsos caused by the upper torso restraints sliding off the shoulders. In forward-facing seats (the type specifically addressed by that AC), occupant motion during rebound and any subsequent re-loading of the belts is limited by interaction with the seat backs. However, in side-facing seats subjected to a forward impact, the restraint systems may be the only means of limiting the occupants' rearward (rebound) motion. So to limit abdominal injury risk in side-facing seats, the lap belts must remain on the pelvis throughout the impact event, including rebound.

During side-facing-seat dynamic tests, the risk for head injury is assessed with only one occupant size (the 50th percentile male as represented by the ES–2re as defined in 49 CFR part 572 supbart U). However, protection for a range of occupant statures can be provided if the impacted surface is homogenous in the area contactable by that range of occupants.

The FAA has issued special conditions in the past for airbag systems on lap belts for some forward-facing seats. These special conditions for the airbag systems in the shoulder belts are based on the previous special conditions for airbag systems on lap belts with some changes to address the specific issues of side-facing seats. The special conditions are not an installation approval. Therefore, while the special conditions relate to each such system installed, the overall installation approval is a separate finding and must consider the combined effects of all such systems installed.

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

For the reasons discussed above, 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.

Discussion of Comments

Notice of proposed special conditions No. 25–13–02–SC for the Embraer Model EMB–550 airplanes was published in the **Federal Register** on May 6, 2013 (78 FR 26280). No comments were received, and the special conditions are adopted as proposed.

Applicability

As discussed above, these special conditions are applicable to the Embraer Model EMB–550 airplane. Should Embraer S.A. 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 one model 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 Embraer Model EMB–550 airplanes.

In addition to the requirements of §§ 25.562 and 25.785, the following special condition numbers 1 and 2 are part of the type certification basis of the Model EMB–550 airplane with side-facing-seat installations. For seat places equipped with airbag systems in the shoulder belts, additional special condition numbers 3 through 16 are part of the type certification basis.

1. Additional requirements applicable to tests or rational analysis conducted to show compliance with §§ 25.562 and 25.785 for side-facing seats:

(a) The longitudinal test(s) conducted in accordance with § 25.562(b)(2) to show compliance with the seat-strength requirements of § 25.562(c)(7) and (8) and these special conditions must have an ES–2re anthropomorphic test dummy (ATD) (49 CFR part 572 subpart U) or equivalent, or a Hybrid-II ATD (49 CFR part 572, subpart B as specified in § 25.562) or equivalent occupying each seat position and including all items contactable by the occupant (e.g., armrest, interior wall, or furnishing) if those items are necessary to restrain the occupant. If included, the floor representation and contactable items must be located such that their relative position, with respect to the center of the nearest seat place, is the same at the start of the test as before floor misalignment is applied. For example, if floor misalignment rotates the centerline of the seat place nearest the contactable item 8 degrees clockwise about the aircraft *x*-axis, then the item and floor representations must be rotated by 8 degrees clockwise also to maintain the same relative position to the seat place, as shown in Figure 1. Each ATD's relative position to the seat after application of floor misalignment must be the same as before misalignment is applied. To ensure proper loading of the seat by the occupants, the ATD pelvis must remain supported by the seat pan, and the restraint system must remain on the pelvis and shoulder of the ATD until rebound begins. No injury-criteria evaluation is necessary for tests conducted only to assess seat-strength requirements.

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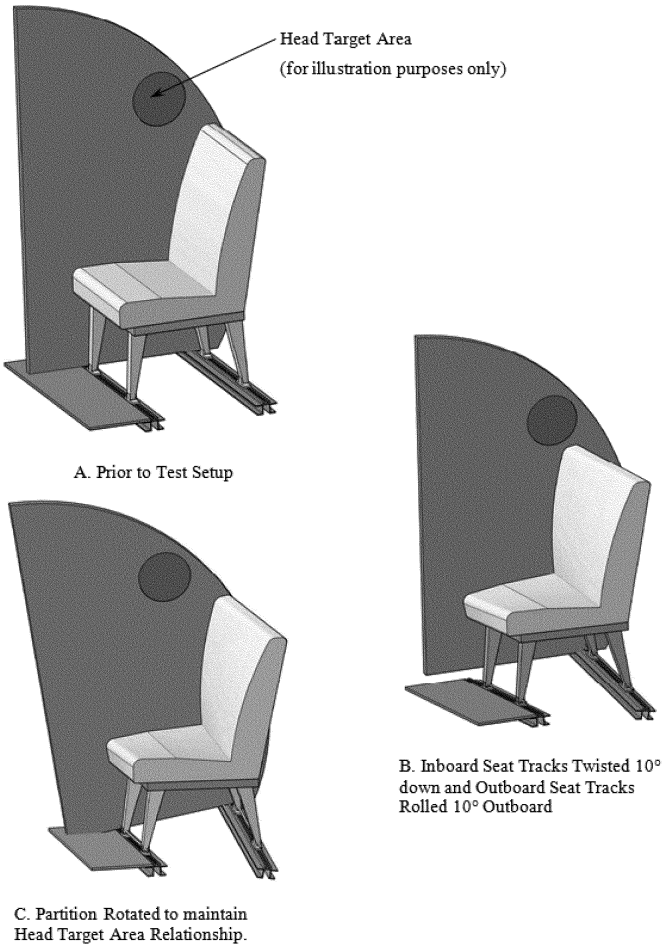

Figure 1: Head Target Areas Relative to Seat Position

(b) The longitudinal test(s) conducted in accordance with § 25.562(b)(2) to show compliance with the injury assessments required by § 25.562(c) and these special conditions may be conducted separately from the test(s) to show structural integrity. In this case, structural-assessment tests must be conducted as specified in paragraph 1(a)

of these special conditions, and the injury-assessment test must be conducted without yaw or floor misalignment. Injury assessments may be accomplished by testing with ES–2re ATD (49 CFR part 572 subpart U) or equivalent at all places. Alternatively, these assessments may be accomplished by multiple tests that use an ES–2re at the seat place being evaluated and a Hybrid-II ATD (49 CFR part 572, subpart B, as specified in § 25.562) or equivalent used in all seat places forward of the one being assessed to evaluate occupant interaction. In this case, seat places aft of the one being assessed may be unoccupied. If a seat installation includes adjacent items that are contactable by the occupant, the injury potential of that contact must be assessed. To make this assessment, tests may be conducted that include the actual item located and attached in a representative fashion. Alternatively, the injury potential may be assessed by a combination of tests with items having the same geometry as the actual item but having stiffness characteristics that would create the worst case for injury (injuries due to both contact with the item and lack of support from the item).

(c) If a seat is installed aft of a structure (e.g., an interior wall or furnishing) that does not have a homogeneous surface contactable by the occupant, additional analysis and/or test(s) may be required to demonstrate that the injury criteria are met for the area which an occupant could contact. For example, different yaw angles could result in different injury considerations and may require additional analysis or separate test(s) to evaluate.

(d) To accommodate a range of occupant heights (5th percentile female to 95th percentile male), the surface of items contactable by the occupant must be homogenous 7.3 inches (185 mm) above and 7.9 inches (200 mm) below the point (center of area) that is contacted by the 50th percentile male size ATD's head during the longitudinal test(s) conducted in accordance with paragraphs 1(a), 1(b), and 1(c) of these special conditions. Otherwise, additional head-injury criteria (HIC) assessment tests may be necessary. Any surface (inflatable or otherwise) that provides support for the occupant of any seat place must provide that support in a consistent manner regardless of occupant stature. For example, if an inflatable shoulder belt is used to mitigate injury risk, then it must be demonstrated by inspection to bear against the range of occupants in a similar manner before and after inflation. Likewise, the means of limiting lower-leg flail must be demonstrated by inspection to provide protection for the range of occupants in a similar manner.

(e) For longitudinal test(s) conducted in accordance with § 25.562(b)(2) and these special conditions, the ATDs must be positioned, clothed, and have lateral instrumentation configured as follows:

(1) ATD positioning:

(i) Lower the ATD vertically into the seat while simultaneously (see Figure 2 for illustration):

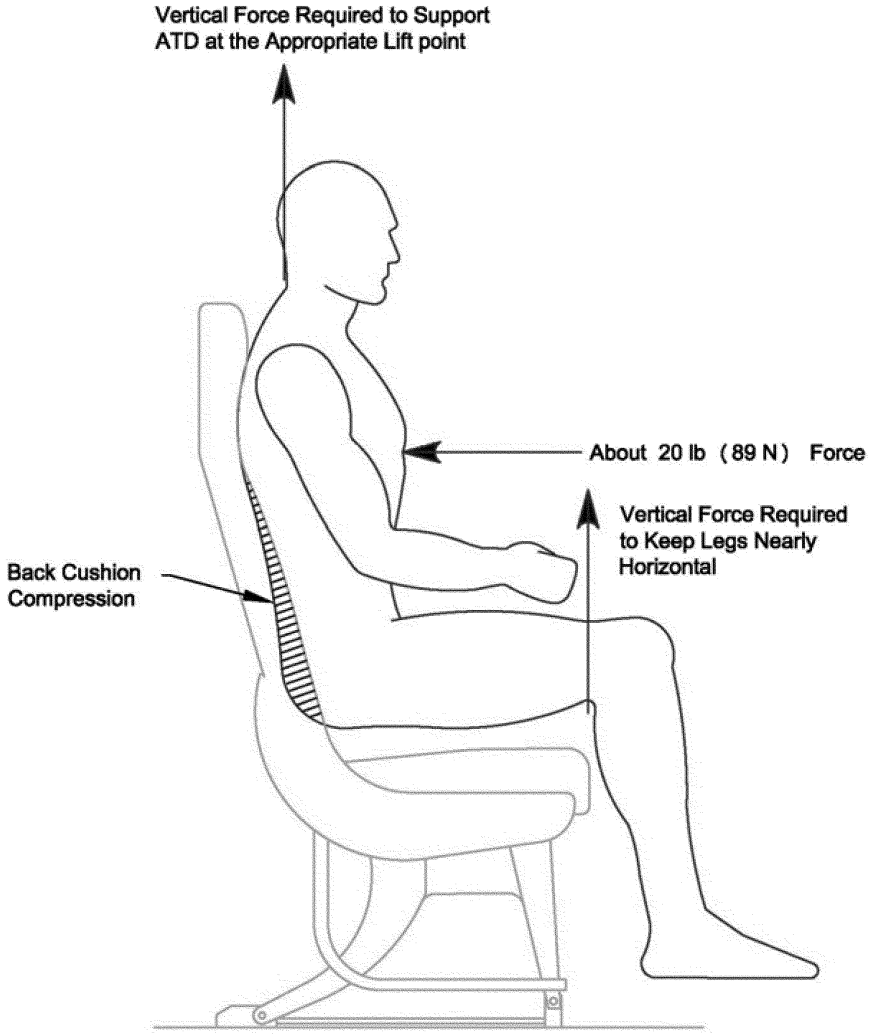

Figure 2: ATD Positioning

(A) Aligning the midsagittal plane (a vertical plane through the midline of the body; dividing the body into right and left halves) with approximately the middle of the seat place.

(B) Applying a horizontal *x*-axis direction (in the ATD coordinate system) force of about 20 pounds (lbs) (89 Newtons [N]) to the torso at approximately the intersection of the midsagittal plane and the bottom rib of the ES–2re or lower sternum of the Hybrid-II at the midsagittal plane, to compress the seat back cushion.

(C) Keeping the upper legs nearly horizontal by supporting them just behind the knees.

(ii) Once all lifting devices have been removed from the ATD:

(A) Rock it slightly to settle it in the seat.

(B) Separate the knees by about 4 inches (100 mm).

(C) Set the ES–2re's head at approximately the midpoint of the available range of *z*-axis rotation (to align the head and torso midsagittal planes).

(D) Position the ES–2re's arms at the joint's mechanical detent that puts them at approximately a 40-degree angle with respect to the torso. Position the Hybrid-II ATD hands on top of its upper legs.

(E) Position the feet such that the centerlines of the lower legs are approximately parallel to a lateral vertical plane (in the aircraft coordinate system).

(2) ATD clothing: Clothe each ATD in form-fitting, mid-calf-length (minimum) pants and shoes (size 11E) weighing about 2.5 lb (1.1 kg) total. The color of the clothing should be in contrast to the color of the restraint system. The ES–2re jacket is sufficient for torso clothing, although a form-fitting shirt may be used in addition if desired.

(3) ES–2re ATD lateral instrumentation: The rib-module linear slides are directional, i.e., deflection occurs in either a positive or negative ATD *y*-axis direction. The modules must be installed such that the moving end of the rib module is toward the front of the aircraft. The three abdominal force sensors must be installed such that they are on the side of the ATD toward the front of the aircraft.

(f) The combined horizontal/vertical test, required by § 25.562(b)(1) and these special conditions, must be conducted with a Hybrid II ATD (49 CFR part 572, subpart B, as specified in § 25.562), or equivalent, occupying each seat position.

(g) Restraint systems:

(1) If inflatable restraint systems are used, they must be active during all dynamic tests conducted to show compliance with § 25.562.

(2) The design and installation of seat-belt buckles must prevent unbuckling due to applied inertial forces or impact of the hands/arms of the occupant during an emergency landing.

2. Additional performance measures applicable to tests and rational analysis conducted to show compliance with §§ 25.562 and 25.785 for side-facing seats:

(a) Body-to-body contact: Contact between the head, pelvis, torso, or shoulder area of one ATD with the adjacent-seated ATD's head, pelvis, torso, or shoulder area is not allowed. Contact during rebound is allowed.

(b) Thoracic: The deflection of any of the ES–2re ATD upper, middle, and lower ribs must not exceed 1.73 inches (44 mm). Data must be processed as defined in Federal Motor Vehicle Safety Standards (FMVSS) 571.214.

(c) Abdominal: The sum of the measured ES–2re ATD front, middle, and rear abdominal forces must not exceed 562 lb (2,500 N). Data must be processed as defined in FMVSS 571.214.

(d) Pelvic: The pubic symphysis force measured by the ES–2re ATD must not exceed 1,350 lb (6,000 N). Data must be processed as defined in FMVSS 571.214.

(e) Leg: Axial rotation of the upper-leg (femur) must be limited to 35 degrees in either direction from the nominal seated position.

(f) Neck: As measured by the ES–2re ATD and filtered at channel frequency class (CFC) 600 as defined in SAE J211:

(1) The upper-neck tension force at the occipital condyle location must be less than 405 lb (1,800 N).

(2) The upper-neck compression force at the occipital condyle location must be less than 405 lb (1,800 N).

(3) The upper-neck bending torque about the ATD *x*-axis at the occipital condyle location must be less than 1,018 in-lb (115 Nm).

(4) The upper-neck resultant shear force at the occipital condyle location must be less than 186 lb (825 N).

(g) Occupant (ES–2re ATD) retention: The pelvic restraint must remain on the ES–2re ATD's pelvis during the impact and rebound phases of the test. The upper-torso restraint straps (if present) must remain on the ATD's shoulder during the impact.

(h) Occupant (ES–2re ATD) support:

(1) Pelvis excursion: The load-bearing portion of the bottom of the ATD pelvis must not translate beyond the edges of its seat's bottom seat-cushion supporting structure.

(2) Upper-torso support: The lateral flexion of the ATD torso must not exceed 40 degrees from the normal upright position during the impact.

3. For seats with airbag systems in the shoulder belts, show that the airbag systems in the shoulder belts will deploy and provide protection under crash conditions where it is necessary to prevent serious injury. The means of protection must take into consideration a range of stature from a 2-year-old child to a 95th percentile male. The airbag systems in the shoulder belts must provide a consistent approach to energy absorption throughout that range of occupants. When the seat systems include airbag systems, the systems must be included in each of the certification tests as they would be installed in the airplane. In addition, the following situations must be considered:

(a) The seat occupant is holding an infant.

(b) The seat occupant is a pregnant woman.

4. The airbag systems in the shoulder belts must provide adequate protection for each occupant regardless of the number of occupants of the seat assembly, considering that unoccupied seats may have active airbag systems in the shoulder belts.

5. The design must prevent the airbag systems in the shoulder belts from being either incorrectly buckled or incorrectly installed, such that the airbag systems in the shoulder belts would not properly deploy. Alternatively, it must be shown that such deployment is not hazardous to the occupant and will provide the required injury protection.

6. It must be shown that the airbag systems in the shoulder belts are not susceptible to inadvertent deployment as a result of wear and tear, inertial loads resulting from in-flight or ground maneuvers (e.g., including gusts and hard landings), and other operating and environmental conditions (e.g., vibrations and moisture) likely to occur in service.

7. Deployment of the airbag systems in the shoulder belts must not introduce injury mechanisms to the seated occupants or result in injuries that could impede rapid egress. This assessment should include an occupant whose belt is loosely fastened.

8. It must be shown that inadvertent deployment of the airbag systems in the shoulder belts, during the most critical part of the flight, will either meet the requirement of § 25.1309(b) or not cause a hazard to the airplane or its occupants.

9. It must be shown that the airbag systems in the shoulder belts will not impede rapid egress of occupants 10 seconds after airbag deployment.

10. The airbag systems must be protected from lightning and high-intensity radiated fields (HIRF). The threats to the airplane specified in existing regulations regarding lighting, § 25.1316, and HIRF, § 25.1317, are incorporated by reference for the purpose of measuring lightning and HIRF protection.

11. The airbag systems in the shoulder belts must function properly after loss of normal aircraft electrical power and after a transverse separation of the fuselage at the most critical location. A separation at the location of the airbag systems in the shoulder belts does not have to be considered.

12. It must be shown that the airbag systems in the shoulder belts will not release hazardous quantities of gas or particulate matter into the cabin.

13. The airbag systems in the shoulder-belt installations must be protected from the effects of fire such that no hazard to occupants will result.

14. A means must be available for a crew member to verify the integrity of the airbag systems in the shoulder-belts activation system prior to each flight or it must be demonstrated to reliably operate between inspection intervals. The FAA considers that the loss of the airbag-system deployment function alone (i.e., independent of the conditional event that requires the airbag-system deployment) is a major-failure condition.

15. The inflatable material may not have an average burn rate of greater than 2.5 inches/minute when tested using the horizontal flammability test defined in part 25, appendix F, part I, paragraph (b)(5).

16. Once deployed, the airbag systems in the shoulder belts must not adversely affect the emergency-lighting system (e.g., block floor proximity lights to the extent that the lights no longer meet their intended function).

Issued in Renton, Washington, on August 9, 2013.

Jeffrey E. Duven,

Acting Manager, Transport Airplane Directorate, Aircraft Certification Service.

[FR Doc. 2013–19754 Filed 8–14–13; 8:45 am]

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 39

[Docket No. FAA–2013–0262; Directorate Identifier 2013–NE–13–AD; Amendment 39–17548; AD 2013–16–10]

RIN 2120–AA64

Airworthiness Directives; Hamilton Standard Division and Hamilton Sundstrand Corporation Propellers

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.