U.S. Department
of Transportation

Federal Aviation Administration

Memorandum

Subject: INFORMATION: Policy Statement on an Acceptable Method of Compliance with § 25.562 for Replacing Restraint Systems on Forward and Aft Facing Seats

Date: Proposed

From: Manager, Transport Airplane Directorate, Aircraft Certification Service, ANM-100

Reply to Attn. of: ANM-115-05-10

To: See Distribution

Regulatory Reference: 25.562

Summary

The purpose of this memorandum is to provide an acceptable method of compliance with § 25.562 for replacing lap safety belts (2-point restraint systems) and torso restraint systems (3, 4 and 5-point restraint systems) on previously approved forward and aft facing seats.

Current Regulatory and Advisory Material

Section 25.562 requires that seats (including their restraint systems) successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar type seat. Section 25.562 also requires the seat and restraint system be designed to protect each occupant during the emergency landing conditions when (1) proper use is made of seats, safety belts and shoulder harnesses provided for in the design; and (2) the occupant is exposed to loads resulting from the conditions specified in § 25.562(b).

Technical Standard Orders (TSO) C22g and C114 prescribe the minimum performance standards that lap safety belts and torso restraint systems must meet to be identified with the applicable TSO marking, respectively. Both of these TSOs require, with some exceptions, compliance with the standards in Society of Automotive Engineers, Inc. (SAE), Aerospace Standard (AS) 8043, “Aircraft Torso Restraint System,” dated March 1986.

Background

The FAA issued Amendment 25-64 to provide an increased level of safety to seated occupants. Seat performance, including the restraint system, under dynamic conditions as defined in § 25.562(b), is an important consideration of this amendment. Replacing a restraint system on a seat certified under § 25.562 with a different restraint system typically requires new dynamic test(s) to be conducted using the actual seat. These dynamic tests can be costly and time-consuming. The FAA conducted research and found an acceptable new method of certifying restraint systems using a rigid seat fixture

instead of the actual seat during dynamic tests. This method will significantly reduce the cost and time associated with certifying replacement restraint systems. This policy memorandum presents this new means of compliance.

Policy

We have found the following method acceptable for showing compliance with § 25.562 for a replacement restraint system installed on forward and/or aft facing seats. The method compares the performance of a proposed replacement restraint system to a restraint system previously certificated by testing with the production seat. The geometry of these restraints should be essentially the same in terms of the locations where the webbing segments (for example, lap belt segment, upper torso segment) attach to each other and hardware (buckles, emergency locking retractors).

Test Setup

- Mount the certificated and replacement restraint systems to rigid seat fixtures. Install the fixtures side-by-side on a common dynamic test sled. This will ensure that each seat fixture will be subjected to the same impact condition.

- Install measuring devices, such as load cells or tensiometers, to accurately determine restraint loads applied to the restraint anchor points.

- Extremes of temperature and humidity can affect anthropomorphic test dummy (ATD) performance. Therefore, keep ATDs at a temperature range between 66 to 78 degrees F (19 to 26 degrees C) and at a relative humidity from 10 to 70 percent for a minimum of 4 hours before the test.

- The restraint anchors, restraint anchor locations, seat cushions, ATD positions and seat reference points (SRP) for both test fixture seat places should be representative of the certificated seat. See AS 8049A, "Performance Standard for Seats in Civil Rotorcraft, Transport Aircraft, and General Aviation Aircraft," dated September 1997, which defines SRP. Both seat places of the rigid seat fixtures should have seat cushions of the same construction.

- Each rigid seat fixture should have a floor that positions the ATD's feet in the same relative position as when seated in the certificated seat. The installed floor should not unduly restrict movement of the ATD's feet, unless it represents rudder pedals.

Test Conditions

Except for the following, conduct the test per § 25.562(b)(2):

- Do not yaw the rigid seat fixtures and do not deform the floor.

- Face the rigid seat fixtures forward; even to support a replacement restraint for an aft facing seat.

Acceptance Criteria

Compare the performance of the proposed and certificated restraint systems. The acceptance criteria are as follows:

- The peak restraint loads applied to the restraint anchor points should be within +/- 6% of each other.

- The points of maximum ATD head excursion should be within +/- 1.0 inch of each other. Use the SRP as the reference datum for determining the head path.

- Evaluate the ATD head trajectories from their initial positions to their points of maximum excursion. There should be no significant differences between the head paths, such as those caused by the performances of inertia reels (that is, payout or spooling.)

- The proposed and certificated restraint systems should not experience a structural failure (for example, webbing tear or cut, hardware structural failure) during the test. The upper torso restraint straps should remain on the ATDs' shoulders, and the pelvic restraints should remain on the ATDs' pelvises during the impact.

- If installed, the emergency locking retractors (inertia reels) of both the proposed and certificated restraint systems should meet the requirements in AS 8043 sections 5.9 and 8.9.

Additional Acceptance Criteria for Torso Restraint Systems

For torso restraint systems (3, 4 and 5-point restraint systems), the following criteria also apply:

  - The proposed restraint systems (webbing and structural components) should meet the strength requirements in AS 8043.

- Each segment of the proposed restraint system (for example, the pelvic restraint portion, upper torso restraint portion), except for the fifth belt of a 5-point restraint system that holds the restraint system in place and does not react much load, should be statically tested to failure by the below procedure. The strength at failure of each segment of the proposed restraint should be within 6%, or be greater than, the strength at failure of the corresponding segment of the certificated restraint system. As an alternative to statically testing a restraint segment to failure, a proposed restraint segment is considered to have sufficient strength if the peak load it reacts during the rigid seat test is equal to, or greater than, the peak load reacted by the corresponding certificated restraint segment during its certification testing (that is, the test with the certificated restraint installed on the seat that the replacement restraint is proposed to be installed on.) This alternative method will often be useful since the loads in upper torso restraints are determined in seat certification tests to demonstrate compliance with § 25.562(c)(1).

Static Test Procedure for Pelvic Restraint Segment:

- Install the pelvic restraint (structural components and webbing) by itself or as part of the entire system on a rigid test block as shown in AS 8043, Figure 2.
- Adjust the pelvic restraint to a length of 1220 to 1270 mm (48 to 50 in), or as near as possible.
- Apply a balanced loop load to the pelvic restraint and slowly increase it until failure. See AS 8043, section 2.7 for a definition of loop load.

Static Test Procedure for Upper Torso Restraint Segment(s):

- Install the torso restraint system (webbing, structural components, emergency locking retractor) on a rigid test block in accordance with AS 8043, paragraph 9.1.
- Apply load to the pelvic restraint and the upper torso restraint(s) in accordance with AS 8043, paragraph 9.3 or 9.4, as applicable. After achieving the maximum loads, slowly increase the load in the upper anchorage(s) of the upper torso restraint(s) until failure. For restraint systems with two different upper torso restraints (dual shoulder belts), the test will need to be conducted twice so that the strength at failure of each upper torso restraint can be determined. Surrogate parts that are stronger than actual components of the restraint system (for example, stronger webbing) may be used for components not being evaluated, to force failures to occur in particular segments of the restraint system.

Discussion

The acceptance criteria require the peak restraint loads applied to the anchor points and the points of maximum ATD head excursion to be within +/- 6.0 % and +/- 1.0 inch, respectively. The FAA bases these criteria on their correlation to the variances in load and head path data that occur in tests conducted in accordance with § 25.562(b) of same part number seats. In other words, there is scatter in the results of dynamic seat tests conducted in accordance with § 25.562(b) due to factors such as ATD positioning, restraint system tightness, photometric analysis, etc. The FAA considers that a replacement restraint system is equivalent to a certificated restraint system if a comparison test provides the same results, within a range of values consistent with the scatter of results from § 25.562(b) tests, for certain critical parameters. Note that although data scatter has been used to help determine acceptable criteria for a comparison test, it is not acceptable for scatter to be used to justify the acceptability of an installation, which is non-compliant based on a standard compliance test. For example, it is not acceptable to subtract 1 inch (approximate scatter in head path data) from head path results to determine compliance with § 25.562(c)(5) for a front row seat installation.

Data indicate that individual segments of a torso restraint system (for example, the pelvic restraint portion, the upper torso restraint portion) can be subjected to a significantly lower dynamic load during a test using a rigid seat fixture versus a test using the certificated seat. Conversely, the rigid seat fixture tends to overload the other segments of the restraint system. As a result, testing using a rigid seat fixture is not sufficient to show that the strength of all segments of a restraint system meet § 25.562. Therefore, the acceptance criteria require the strength of all segments of torso restraint systems be substantiated by static strength testing or the alternative method provided above.

This method of compliance is applicable to restraint systems for both forward and aft facing seats. It requires the rigid seat fixtures to face forward during the comparison test even to substantiate a replacement restraint for an aft facing seat. This seat fixture orientation will evaluate the performance of the emergency locking retractors (inertia reels) at high webbing accelerations and high webbing loads. During standard aft facing seat tests in accordance with § 25.562(b)(2), inertia reels are subjected to lower webbing accelerations and webbing loads due to the seat backs providing a significant amount of restraint to the ATDs. Since inertia reel performance may differ between high and low webbing accelerations and loads, the rigid seat test is not sufficient for ensuring that a proposed inertia reel will perform similarly to a certificated inertia reel during low webbing accelerations and loads. The FAA has reviewed data on this matter and considers that inertia reels that meet the performance criteria of AS 8043 will lock at similar times during high and low webbing acceleration and webbing load events. Therefore, this method of compliance includes a criterion that inertia reels, if installed, should meet the requirements in AS 8043 sections 5.9 and 8.9. The FAA has only evaluated inertia reels that sense movement of the webbing (webbing sensitive inertia reels), so until other types of inertia reels (for example, vehicle sensitive inertia reels) are studied and found acceptable; this method of compliance is only applicable to restraint systems with webbing sensitive inertia reels.

This method of compliance is only applicable for comparing a proposed restraint system to a restraint system, which has been previously qualified by standard testing per § 25.562. That is, it is not acceptable to compare one replacement restraint with another replacement restraint that has been certificated in the manner described in this policy memorandum.

The FAA considers replacement of hardware components in lap safety belts and torso restraint systems as major changes to restraint system TSOs (TSO-C22 or TSO-C114) and require a new TSO application. In certain circumstances where the hardware is similar and has been previously approved on other TSO approved restraints, changes can be considered minor if both TSO approvals are held by the applicant making the change. Changes made to TSO restraint systems by a restraint manufacturer other than the original TSO holder require a new TSO approval in accordance with § 21.611(c).

During the original approval to TSO-C127, the FAA requires the original restraint to be approved with the seat and marked by part number on the seat TSO tag. This policy describes an acceptable method for approving a restraint that replaces the restraint approved with the original TSO-127 approval. In accordance with FAA Order 8150.1b, the seat should be appropriately marked when a replacement restraint has been installed and approved for use. Replacing the restraint on a TSO-C127 seat is considered a minor change when made by the original seat TSO approval holder. See policy memo PS-AIR100-9/8/2003 “Classification of Design Changes to TSO-C39b, TSO-C127, and TSO-C127a Articles” for more information. All modifications made by applicants other than the original seat TSO holder to a seat initially approved under a TSO (TSO-C39 or TSO-C127) should be done in accordance with Advisory Circular (AC) 21-25A in order to comply with § 21.611(c).

Effect of Policy

The general policy stated in this document does not constitute a new regulation or create what the courts refer to as a "binding norm." The office that implements policy should follow this policy when applicable to the specific project. Whenever an applicant's proposed method of compliance is outside this established policy, it must be coordinated with the policy issuing office, for example, through the issue paper process or equivalent. Similarly, if the implementing office becomes aware of reasons that an applicant's proposal that meets this policy should not be approved, the office must coordinate its response with the policy issuing office.

Applicants should expect that the certificating officials will consider this information when making findings of compliance relevant to new certificate actions. Also, as with all advisory material, this statement of policy identifies one means, but not the only means, of compliance.

Implementation

The compliance method discussed in this policy should be applied to type certificate, amended type certificate, supplemental type certificate, and amended supplemental type certification programs whose application date is on or after the date the policy is finalized. For existing certification programs whose application precedes the date this policy is effective and the methods of compliance have already been coordinated with and approved by the FAA or their designee, the applicant may continue to follow the previously acceptable methods of compliance or choose to follow the guidance contained in this policy.

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