U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: STATIC STRENGTH SUBSTANTIATION OF ATTACHMENT POINTS FOR OCCUPANT RESTRAINT SYSTEM INSTALLATIONS
Date: 6/20/86
Initiated by: ACE-100
AC No: 23-4
Change:

1. PURPOSE. This advisory circular (AC) provides information and guidance regarding an acceptable means, but not the only means, of compliance with Part 23 of the Federal Aviation Regulations (FAR) applicable to the static strength substantiation of the attachment points for occupant restraint system installations which have both a safety belt and shoulder harness. This material is neither mandatory nor regulatory in nature and does not constitute a regulation.

2. RELATED REGULATIONS. These acceptable means of compliance refer to certain provisions of Parts 23 and 91 of the FAR for airplanes for which these regulations are applicable. Listed below are the applicable FAR sections:

a. 23.561

b. 23.625

c. 23.785

d. 23.1413

e. 91.7

f. 91.14

g. 91.33

3. RELATED READING MATERIAL.

a. TSO-C22f, "Safety Belts," Technical Standard Order, Federal Aviation Administration, February 24, 1972.

b. TSO-C39a, "Aircraft Seats and Berths," Technical Standard Order, Federal Aviation Administration, February 24, 1972.

c. "Motor Vehicle Seat Belt Anchorages Test Procedure - SAE J384," SAE Recommended Practice, 1979 SAE Handbook, Volume 2, pp. 33.08-33.09, Society of Automotive Engineers, Inc., 1979.

d. Advisory Circular (AC) 43.13-2A, Chapter 9, Federal Aviation Administration, revised 1977.

4. BACKGROUND. Sections 23.785, 23.625(d), and 23.1413 require that the rated strength of safety belts and shoulder harnesses be no less than the loads resulting from applying the ultimate inertia forces specified in § 23.561(b). For small airplanes, § 23.785 requires that each seat be equipped with a safety belt and shoulder harness. Procedures for approving safety belts are provided in TSO-C22f and performance standards for seats with safety belts only are provided in TSO-C39a. However, methods of demonstrating compliance with the installation strength requirements of attachment points for combined safety belt and shoulder harness installations have not been addressed in the Technical Standard Orders (TSOs) or in previous advisory material.

5. DISCUSSION.

a. The addition of a shoulder harness to the restraint system can complicate the load distribution in the restraint system which may produce unpredictable results during the static strength substantiation of the restraint system installation. The load distribution to the safety belt and shoulder harness influences the load requirements for the anchorage points and, thus, must be considered during the static strength substantiation. The restraint system installation geometry can also affect the strength capabilities. Consequently, test conditions which provide representative load distribution to each of the restraint system segments are essential for valid static strength substantiation of the attachment points for an occupant restraint system installation.

b. When determining valid load distributions, conditions for which the shoulder harness is not being used, or is not effectively loaded, need to be considered. In such cases, the safety belt will carry all, or nearly all, of the restraint load. For this reason, at least two load conditions should be considered when evaluating the static strength of attachment points for the occupant restraint system installation. One load condition should provide for a combined loading of the safety belt and shoulder harness, while the other condition should provide for loading of only the safety belt.

c. Methods for substantiating the static strength of aircraft safety belts are defined in TSO-C22f; however, there are no similar standards for aircraft restraint systems which have shoulder harnesses. In the automobile industry, procedures for evaluating the static strength of belt anchorages of restraint systems with shoulder harnesses are defined in SAE Recommended Practice J384. The test methods described in references 3b and 3c are the basis for the technical procedures in this AC.

d. The Federal Aviation Administration (FAA) has reviewed the technology of restraint system evaluation. As a result, this AC presents acceptable methods for substantiating the static strength of attachment points for occupant restraint system installations which incorporate both a safety belt and a shoulder harness.

e. It is recommended that a safety belt and shoulder harness which meet the strength requirements of TSO-C22f be selected.

6. ACCEPTABLE MEANS OF COMPLIANCE. The test procedures below provide an acceptable means of demonstrating the static strength of attachment points for an occupant restraint system installation which consists of both a lap belt and a shoulder harness. Attachment fittings being tested should include the attachment hardware of the restraint system assembly, including the inertia reel where applicable, as well as the structural connections on the seat or airframe. The test fixture or specimen configuration should be based on the particular design of the airplane and seat being substantiated. Both of the tests described below are necessary to adequately substantiate the installation static strength.

a. Safety Belt Installation Test Procedure.

(1) Install the safety belt and shoulder harness assembly, including retractors, inertia reels, length adjustors, anchor hardware, and buckles, in the test fixture using a test block similar to the lower torso block illustrated in figure 1, with the shoulder harness disconnected or unanchored.

(2) Manually adjust the safety belt for a snug fit on the test block with the buckle in a position representative of use with a shoulder harness. Manually lock any safety belt retractors in the assembly with enough tension in the belt to maintain the locked condition and prevent webbing extension.

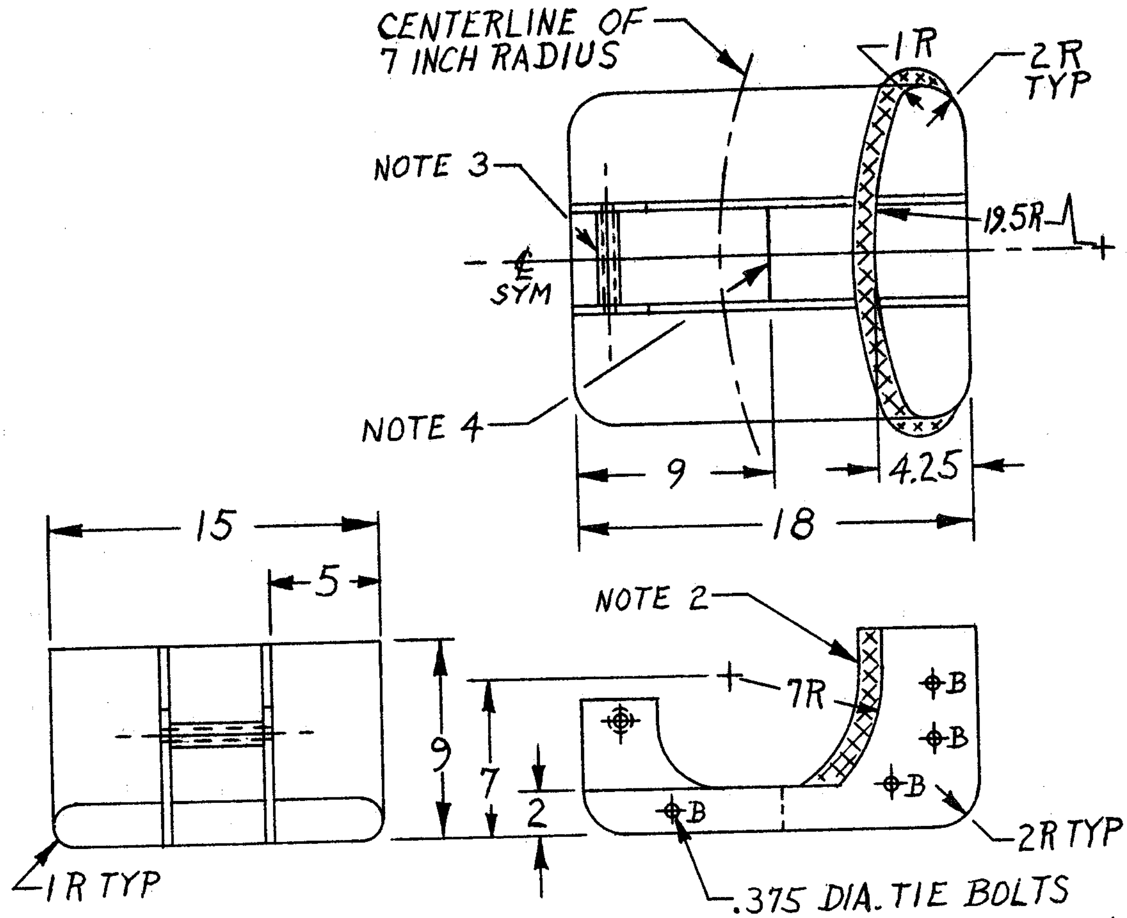
(3) For installations in normal category airplanes, apply a test load of at least 1530 lbs. (9g x 170 lbs.) as shown in figure 3. For installations in utility and acrobatic category airplanes, apply a load of at least 1710 lbs. (9g x 190 lbs.) as shown in figure 3. The load should be applied in the forward direction of the airplane longitudinal axis and held for at least 3 seconds without failure.

(4) After relieving the safety belt test load, examine the safety belt for integrity. Hardware fractures, webbing cuts, or webbing slippage of more than 1.0 in. through the adjustor should be considered unacceptable.

(5) To substantiate the attachment fittings, repeat the test procedure of paragraphs 6a(1), 6a(2), and 6a(3), except apply a test load of at least 2035 lbs. (1.33 x 9g x 170 lbs.) for installations in normal category airplanes, or a test load of at least 2275 lbs. (1.33 x 9g x 190 lbs.) for installations in utility and acrobatic airplanes. The loads should be applied in the forward direction of the airplane longitudinal axis and held for at least 3 seconds without failure. If necessary, steel cable or other high strength devices may be substituted for the belt webbing when testing the fittings, as long as these devices provide the same load distribution as the webbing.

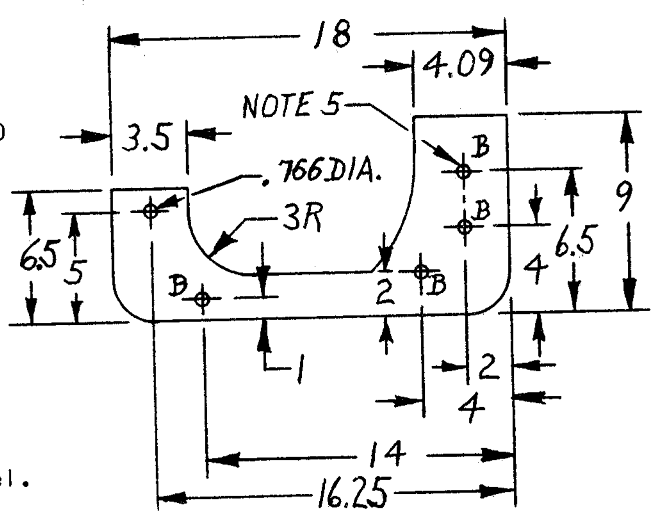
b. Combined Safety Belt and Shoulder Harness Installation Test Procedure.

(1) Install the safety belt and shoulder harness assembly, including retractors, inertia reels, length adjustors, anchorage hardware, and buckles in the test fixture using test blocks similar to the lower torso and shoulder harness blocks illustrated in figures 1 and 2. A separate shoulder harness block should be used for each shoulder harness strap.



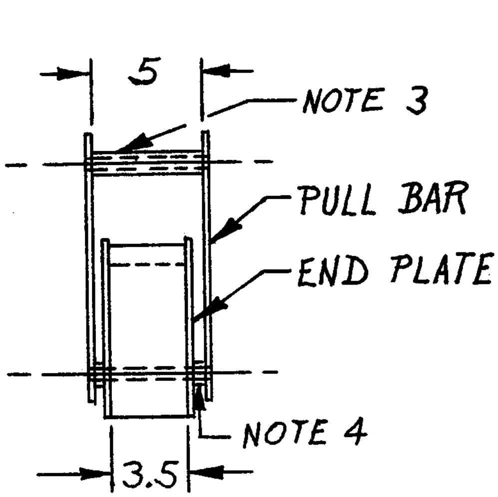
Notes:

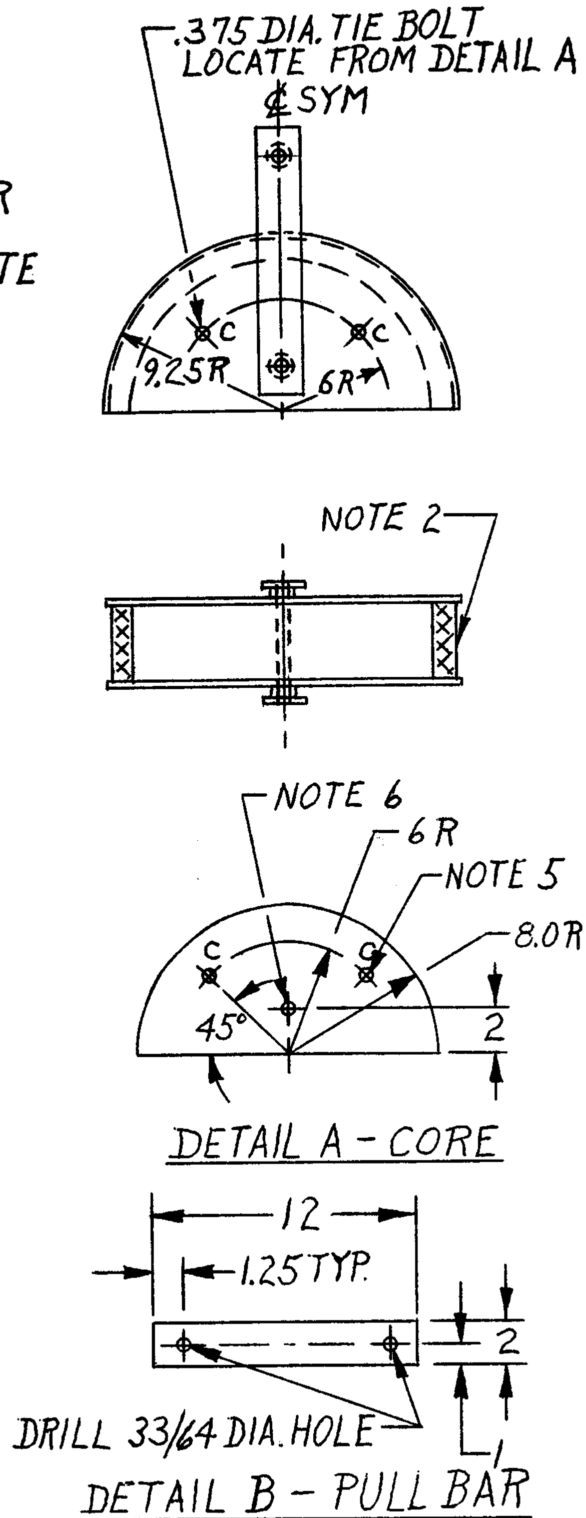
1. All dimensions in inches.
2. This surface covered with nylon over 1.0 inch thick slow rebound foam pad.
3. 1.0 O.D. steel spacer over 0.750 dia. bolt.
4. Remove center section forward of this line as required for tests of restraint system with negative-g strap.
5. Drill 25/64 dia. hole and counterbore as required for attachment bolts at locations labeled "B."
6. Block material: laminated hardwood.
7. Pull plate material: 0.375 steel.



DETAIL A

Figure 1 - LOWER TORSO BLOCK





NOTES:

1. All dimensions are in inches.
2. This surface covered with nylon over 1.0 inch thick slow rebound foam pad.
3. 5.0 long x 1.0 O.D. steel spacer over a 0.500 dia. bolt.
4. 0.50 long x 1.0 O.D. steel spacer (2 places) over a 0.500 dia. bolt.
5. Drill 25/64 dia. hole at locations labeled "C" thru end plates and core.
6. Drill 33/64 dia. hole thru end plates and core.
7. Core material: laminated hardwood.
8. End plate and pull bar material: 0.25 steel.

Figure 2 - SHOULDER HARNESS BLOCK

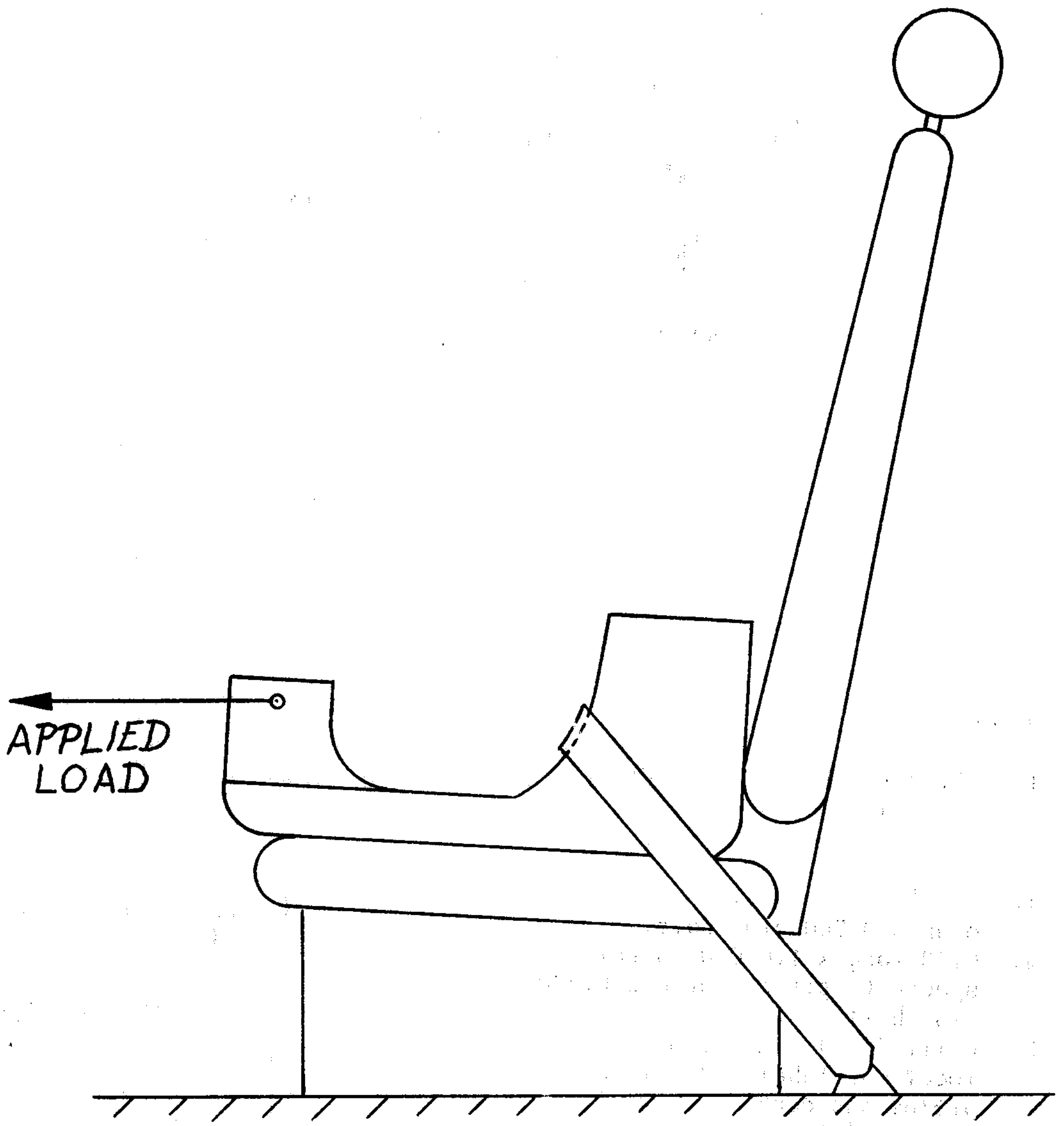


Figure 3 - SAFETY BELT LOADING

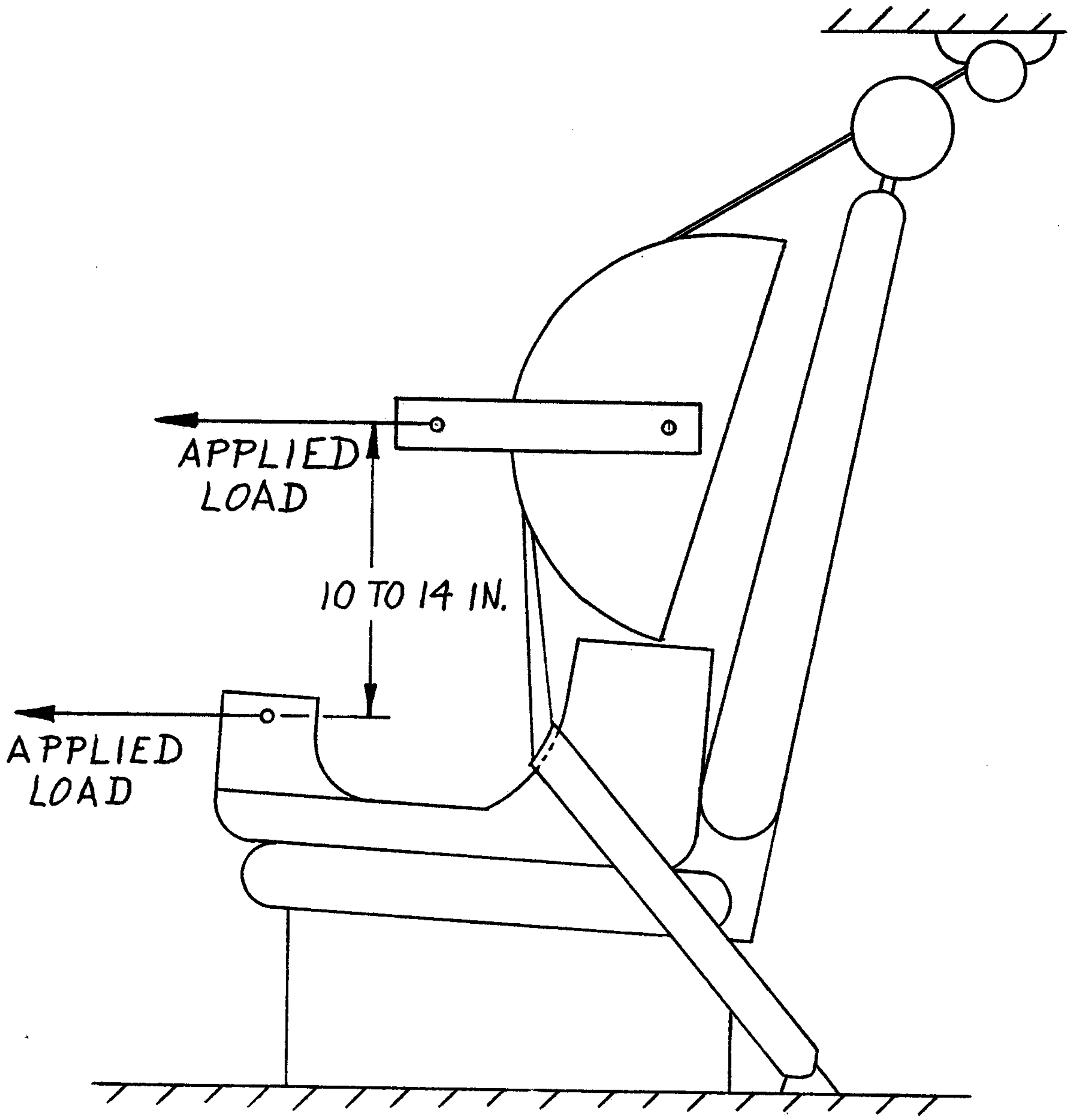


Figure 4 - COMBINED BELT LOADING

(2) Manually adjust the safety belt and shoulder harness for a snug fit over the test blocks. Manually lock any webbing retractors and/or inertia reels in the assembly with enough tension in each segment of the belt and harness to maintain the locked condition and prevent webbing extension.

(3) For installations in normal category airplanes, apply a test load of at least 1530 lbs. with a distribution of at least 918 lbs. to the lower torso block and at least 612 lbs. to the shoulder harness block(s), as shown in figure 4. For installations in utility and acrobatic category airplanes, apply a test load of at least 1710 lbs. with a distribution of at least 1026 lbs. to the lower torso block and at least 684 lbs. to the shoulder harness block(s), as shown in figure 4. The shoulder harness test load should be equally distributed among the shoulder harness straps. The loads should be applied in the forward direction of the airplane longitudinal axis and held for at least 3 seconds without failure.

(4) After relieving the test loads, examine the safety belt and shoulder harness for integrity. Hardware fractures, webbing cuts, or webbing slippage of more than 1.0 in. through the adjustor should be considered unacceptable.

(5) To substantiate the attachment fittings for installations in normal category airplanes, repeat the procedure of paragraphs 6b(1), 6b(2), and 6b(3), except apply a test load of at least 2035 lbs. with a distribution of at least 1221 lbs. to the lower torso block and 814 lbs. to the shoulder harness block(s). To substantiate the attachment fittings for installations in utility and acrobatic category airplanes, apply a test load of at least 2275 lbs. with a distribution of at least 1365 lbs. to the lower torso block and 910 lbs. to the shoulder harness block(s). The shoulder harness test load should be equally distributed among the shoulder harness straps. The loads should be applied in the forward direction of the airplane longitudinal axis and held for at least 3 seconds without failure. If necessary, steel cable or other high strength devices may be substituted for the belt webbing when testing the fittings, as long as these devices provide the same load distribution as the webbing.

c. The test procedures defined in subparagraphs 6a and 6b are based on the assumption that the 9g forward load is the critical strength condition for the restraint system installation. If either the upward or sideward load conditions from § 23.561(b)(2) result in more critical or unique load reactions, due to the restraint system design or the seat orientation, methods similar to those outlined in subparagraphs 6a and 6b of this AC should be developed to substantiate the restraint system installation.

NOTE: Caution should be exercised if an operational airplane is used as a test bed for conducting tests to substantiate the restraint system installation loads because the loads called for in this AC are ultimate loads and may damage the structure. All restraint hardware used in these ultimate load tests should be destroyed and not used in an operational airplane.

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