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automobiles

TEST METHOD 213.1

Infant Restraint Systems

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List of Referenced Documents

SAE International Recommended Practice J211-1, *Instrumentation for Impact Test – Part 1 – Electronic Instrumentation* (July 2007)

Subparts K and R, part 572, chapter V, title 49 of the *Code of Federal Regulations* of the United States (revised as of October 1, 2011)

ASTM International:

Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber, Designation No. D1056-00

Standard Specification for Flexible Cellular Materials—Vinyl Chloride Polymers and Copolymers (Open-Cell Foam), Designation No. D1565-81 (Reapproved 1990)

Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams, Designation No. D3574-08

1. Introduction

Test Method 213.1 — Infant Restraint Systems (May 2011) is referred to in Part 3 of the Motor Vehicle Restraint Systems and Booster Seats Safety Regulations (RSSR).

2. Test Devices to be Used

2.1 Seat Assemblies

2.1.1 Standard seat assembly: The standard seat assembly is mounted on a dynamic test platform, instrumented as set out in subsection 2.2, so that the seat orientation reference line (SORL) is parallel to the direction of travel of the test platform and any movement between the base of the assembly and the platform is prevented. The location of the seat belt anchorage points on the standard seat assembly is illustrated in Figures 3 and 5 of Schedule 7 to the RSSR while the location of the lower universal anchorage system is illustrated in Figures 4 and 6 of Schedule 7 to the RSSR.

2.1.2 Representative aircraft passenger seat: In section 7, “representative aircraft passenger seat” means

- (a) a production aircraft passenger seat that has been approved by the U.S. Federal Aviation Administration or by Transport Canada’s Director, Aircraft Certification, or
- (b) a simulated aircraft passenger seat that conforms to the requirements of Figure 5.

2.2 Test platform:

The test platform shall be instrumented with an accelerometer that is linked to a data processing system, and the accelerometer-sensitive axis shall be parallel to the direction of travel of the test platform. The data shall be filtered with a Class 60 filter, as specified in the SAE International Recommended Practice J211-1, *Instrumentation for Impact Test – Part 1 – Electronic Instrumentation* (July 2007).

2.3 Type 1 seat belt assembly and Type 2 seat belt assembly:

Type 1 and Type 2 seat belt assemblies that meet the requirements of section 209 of Schedule IV to the [Motor Vehicle Safety Regulations](#) and whose webbing is not more than 50 mm wide shall be attached, without the use of retractors or reels of any kind, to the seat belt anchorage points provided on the standard seat assembly.

2.4 Anthropomorphic test device:

For the dynamic tests, select all anthropomorphic test devices (ATD) specified in paragraphs (a) and (b), as required, for testing an infant restraint system for use by infants whose mass and height are within the ranges indicated in the statement referred to in paragraph 316(1)(d) of the RSSR.

- (a) A restraint system that is designed to be used by infants in a specified mass range that includes any infants having a mass of not greater than 5 kg, or by infants in a specified height range that includes any infants whose height is not greater than 650 mm, shall be tested with the Newborn Infant ATD conforming to subpart K, part 572, chapter V, title 49 of the *Code of Federal Regulations* of the United States (revised as of October 1, 2011).
- (b) A restraint system that is designed to be used by infants in a specified mass range that includes any infants having a mass greater than 5 kg but not greater than 10 kg, or by infants in a specified height range that includes any infants whose height is greater than 650 mm but not greater than 850 mm, shall be tested with
 - (i) the Newborn Infant ATD conforming to subpart K, part 572, chapter V, title 49 of the *Code of Federal Regulations* of the United States (revised as of October 1, 2011); and
 - (ii) the CRABI 12-month-old infant ATD conforming to subpart R, part 572, chapter V, title 49 of the *Code of Federal Regulations* of the United States (revised as of October 1, 2011).

2.4.1 The clothing of any ATD, other than the shoes, shall be machine washed in water that is at a temperature of at least 71°C but not more than 82°C and machine dried at a temperature of at least 49°C but not more than 60°C for 30 minutes.

2.4.2 The clothing of any ATD shall consist of,

- (a) for the Newborn Infant ATD, subpart K, no clothes or shoes; and
- (b) for the CRABI 12-month-old infant ATD, subpart R, a cotton-polyester-based tight fitting sweatshirt with long sleeves and ankle-length pants whose combined mass is not more than 0.25 kg.

2.4.3 For the purposes of the dynamic tests, any ATD used shall be conditioned as follows:

- (a) When using the Newborn Infant ATD, subpart K, at an ambient temperature of at least 19°C but not more than 25.5°C and at a relative humidity of at least 10 % but not more than 70 % for at least 4 hours immediately prior to the test.
- (b) When using the CRABI 12-month-old infant ATD, subpart R, at an ambient temperature of at least 20.6°C but not more than 22.2°C and at a relative humidity of at least 10 % but not more than 70 % for at least 4 hours immediately prior to the test.

3. Pre-Test Buckle Release Force Measurement

3.1 If the belts of the restraint system are equipped with buckles, the release force of each buckle is to be measured in accordance with subsections 3.2 to 3.6 before commencing the dynamic tests.

3.2 Place the buckle assembly to be tested on a hard, flat, horizontal surface.

3.3 Each belt end of the buckle shall be pre-loaded as shown in Figure 1(a) such that the anchor end of the buckle is loaded with a 9 N force in the direction away from the buckle in the following manner:

- (a) In the case of buckles designed to secure a single latch plate, the belt latch plate end of the buckle shall be pre-loaded with a 9 N force in the direction away from the buckle.
- (b) In the case of buckles designed to secure two or more latch plates, the belt latch plate ends of the buckle shall be loaded equally such that the total load is 9 N, in the direction away from the buckle.

3.4 For push-button-actuated buckles, the release force shall be applied to the buckle by a conical surface as shown in Figure 1(c) and,

- (a) for push-button-actuated mechanisms with a fixed edge (referred to in Figure 1(b) as “hinge button”), the release force shall be applied at the centreline of the button, 3 mm away from the movable edge directly opposite to the fixed edge, and in the direction that produces maximum releasing effect; and
- (b) for push-button-actuated mechanisms with no fixed edge (referred to in Figure 1(b) as “floating button”), the release force shall be applied at the centre of the release mechanism in the direction that produces the maximum releasing effect.

3.5 For all other buckle release mechanisms, the force shall be applied on the centreline of the buckle lever or finger tab in the direction that produces the maximum releasing effect.

3.6 Measure the force required to release the buckle.

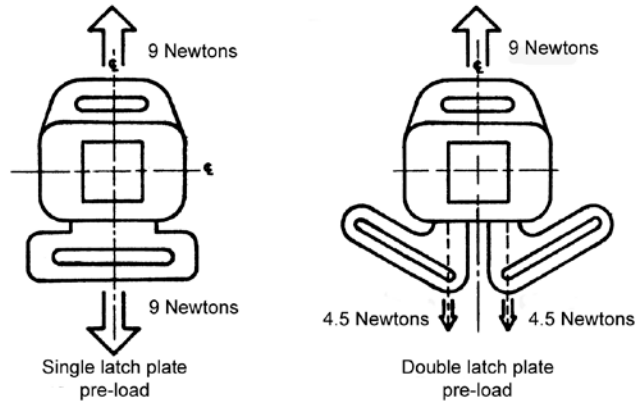


Figure 1(a) — Buckle Pre-load Requirements

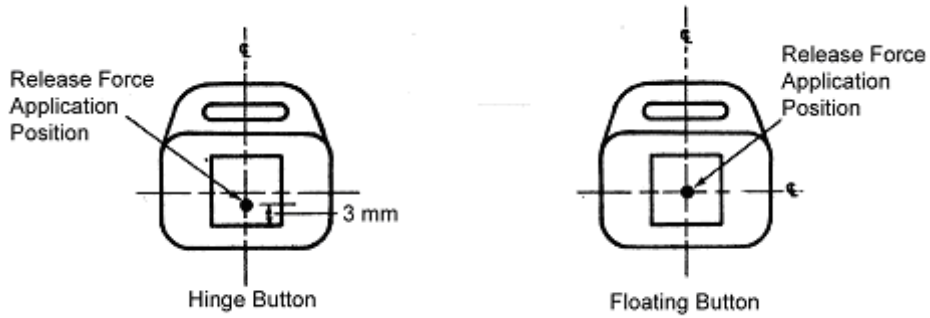


Figure 1(b) — Release Force Application Position for Push-Button Mechanisms

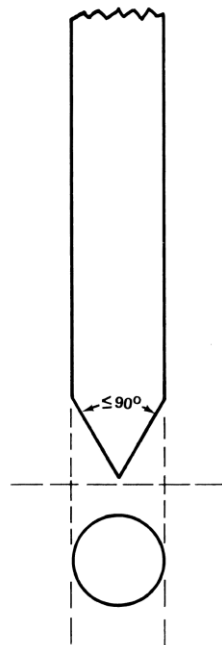


Figure 1(c) — Release Force Application Device

4. Dynamic Tests

4.1 Test Description

- (a) A first dynamic test is to be conducted in accordance with the procedure set out in subsections 4.5 and 4.7 using
 - (i) an ATD specified in subsection 2.4;
 - (ii) a standard seat assembly mounted as set out in subsection 2.1.1; and
 - (iii) a new infant restraint system attached to the standard seat assembly by means of a Type 1 seat belt assembly, as set out in subsection 2.3, with the tether strap if the restraint system is equipped with a tether strap and the manufacturer recommends its use.
- (b) A second dynamic test is to be conducted in accordance with the procedure set out in subsections 4.6 and 4.7 using
 - (i) an ATD specified in subsection 2.4;
 - (ii) a standard seat assembly mounted as set out in subsection 2.1.1; and
 - (iii) a new infant restraint system attached to the standard seat assembly by means of the lower universal anchorage system with the tether strap if the restraint system is equipped with a tether strap and the manufacturer recommends its use.
- (c) A third dynamic test is to be conducted in accordance with the procedure set out in subsections 4.5 and 4.7 using
 - (i) an ATD specified in subsection 2.4;
 - (ii) a standard seat assembly mounted as set out in subsection 2.1.1; and
 - (iii) a new infant restraint system attached to the standard seat assembly by means of a Type 2 seat belt assembly, as set out in subsection 2.3, installed in either configuration of appropriate anchorage points and, with the tether strap if the restraint system is equipped with a tether strap and the manufacturer recommends its use.

4.2 Infant Restraint Systems with a Removable Base

In the case of an infant restraint system that has a removable base, the seating component of which may be used without the base,

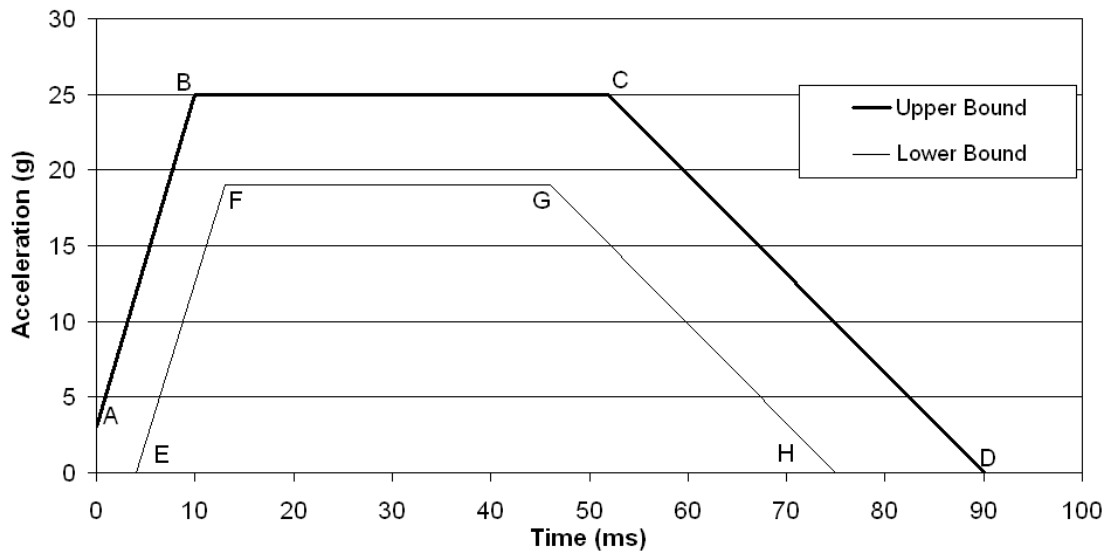
- (a) where lower connectors are supplied on the base only, the tests described in subsections 4.5 and 4.7 are to be conducted for the seating component and the tests described in subsections 4.5 to 4.7 are to be conducted for the base;

- (b) where lower connectors are supplied on both the base and the seating component, the tests described in subsections 4.5 to 4.7 are to be conducted for both the base and the seating component.

4.3 Test Acceleration

The dynamic tests simulate a frontal barrier impact having an acceleration plot of the test platform following every curve that meets the two following requirements:

- (a) it is within the corridor shown in Figure 2; and
- (b) it represents a change of velocity of 48 km/h.



Upper Bound		
Point	Time	Acceleration
A	0	3
B	10	25
C	52	25
D	90	0
Lower Bound		
Point	Time	Acceleration
E	4	0
F	13	19
G	46	19
H	75	0

Figure 2 — Test Platform Acceleration Graph

4.4 Test Conditions

For the dynamic tests, the ambient temperature shall be

- (a) for the Newborn Infant ATD, subpart K, at least 19°C but not more than 26°C with a relative humidity of at least 10 % but not more than 70 %.
- (b) for the CRABI 12-month-old infant, subpart R, at least 20.6°C but not more than 22.2°C with a relative humidity of at least 10 % but not more than 70 %.

4.5 Positioning of the ATD and Installation of the Restraint System for a Dynamic Test Using a Type 1 or Type 2 Seat Belt Assembly

4.5.1 In accordance with the manufacturer's instructions, place a new infant restraint system at the centre seating position of the standard seat assembly. If the restraint system is installed by passing the seat belt assembly over the restraint system and under the seated ATD, attach the seat belt assembly to the restraint system, but do not tighten it. Attach the tether strap if the restraint system is equipped with a tether strap and the manufacturer recommends its use, but do not tighten it.

4.5.2 Any ATD placed in the infant restraint system shall be positioned in accordance with the manufacturer's instructions while conforming to the following:

- (a) Place the ATD in the restraint system so that the back of the ATD's torso contacts the seat back of the restraint system.
- (b) Attach all appropriate belts and harnesses of the restraint system around the ATD and tighten them as specified in subsection 4.5.3.
- (c) In accordance with the manufacturer's instructions, secure the restraint system, if it is not already installed, to the standard seat assembly using the seat belt. Tighten the seat belt assembly in the following manner:
 - (i) In the case of a Type 1 seat belt assembly, tighten the seat belt assembly and tether strap, if the restraint system is equipped with a tether strap and the manufacturer recommends its use, to a tension, as measured by a force gauge used on the webbing, of not less than 53.5 N and not more than 67 N.
 - (ii) In the case of a Type 2 seat belt assembly, tighten the pelvic restraint and tether strap, if the restraint system is equipped with a tether strap and the manufacturer recommends its use, to a tension, as measured by a force gauge used on the webbing, of not less than 53.5 N and not more than 67 N and tighten the upper torso restraint to a tension, as measured by a force gauge used on the webbing, of not less than 9 N and not more than 18 N.
- (d) Position each movable surface in accordance with the instructions referred to in section 318 of the RSSR. If the ATD's head does not remain in the proper position, tape it against the seat back head support surface of the restraint system by means of a single thickness of 6 mm-wide paper masking tape placed across the centre of the ATD's face.
- (e) Extend the ATD's arms vertically upwards and then rotate each arm downward toward the ATD's lower body until the arm contacts a surface of the restraint system or a surface of the standard seat assembly. Ensure that no arm is restrained from movement, other than in the downward direction, by any part of the restraint system or the belts used to secure the restraint system to the standard seat assembly.

4.5.3 If the restraint system is equipped with belts to restrain the upper or lower torso of the ATD, they must be adjusted by tightening the belts until a 9 N force applied using a webbing tension pull device (as illustrated in Figure 3) to the webbing at the top of each shoulder and to the pelvic webbing 50 mm on either side of the mid-sagittal plane of the torso pulls the webbing a distance of 7 mm away from the ATD.

4.6 Positioning of the ATD and Installation of the Restraint System for a Dynamic Test Using a Lower Universal Anchorage System

4.6.1 In accordance with the manufacturer's instructions, place a new infant restraint system at the centre seating position of the standard seat assembly. Attach and adjust the lower connectors of the infant restraint system to the lower universal anchorage system in accordance with the manufacturer's instructions. Attach the tether strap, if the restraint system is equipped with a tether strap and the manufacturer recommends its use, but do not tighten it.

4.6.2 Any ATD placed in the infant restraint system shall be positioned in accordance with the manufacturer's instructions while conforming to the following:

- (a) Place the ATD in the restraint system so that the back of the ATD's torso contacts the seat back of the restraint system.
- (b) Attach all appropriate belts and harnesses of the restraint system around the ATD and tighten them as specified in subsection 4.6.3.
- (c) Tighten the tether strap, if the restraint system is equipped with a tether strap and the manufacturer recommends its use, to a tension of not less than 53.5 N and not more than 67 N, as measured by a force gauge used on the webbing.
- (d) Position each movable surface in accordance with the instructions referred to in section 318 of the RSSR. If the ATD's head does not remain in the proper position, tape it against the seat back head support surface of the restraint system by means of a single thickness of 6 mm-wide paper masking tape placed across the centre of the ATD's face.
- (e) Extend the ATD's arms vertically upwards and then rotate each arm downward toward the ATD's lower body until the arm contacts a surface of the restraint system or a surface of the standard seat assembly. Ensure that no arm is restrained from movement, other than in the downward direction, by any part of the restraint system or the belts used to secure the restraint system to the standard seat assembly.

4.6.3 If the restraint system is equipped with belts to restrain the upper or lower torso of the ATD, they must be adjusted by tightening the belts until a 9 N force applied using a webbing tension pull device (as illustrated in Figure 3) to the webbing at the top of each shoulder and to the pelvic webbing 50 mm on either side of the mid-sagittal plane of the torso pulls the webbing a distance of 7 mm away from the ATD.

4.7 Test Procedure

Accelerate the test platform in accordance with the requirements of subsection 4.3.

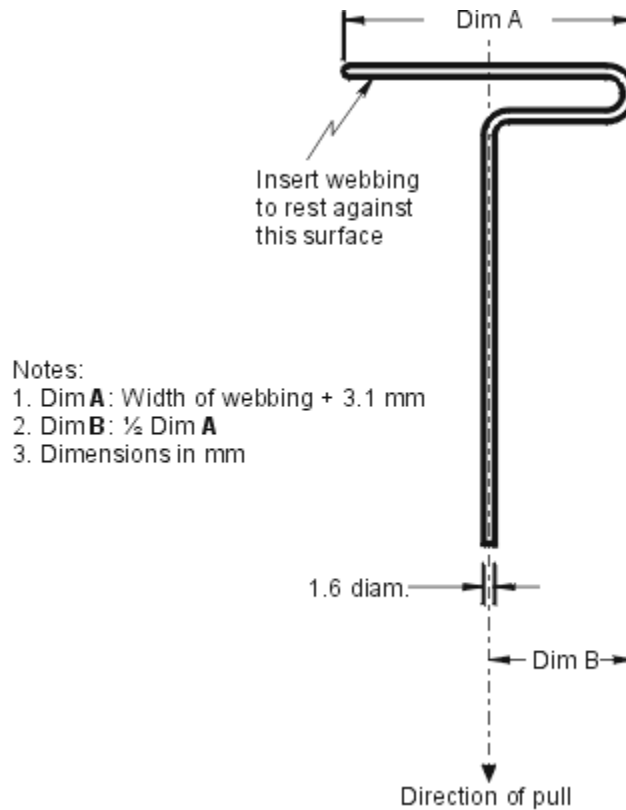


Figure 3 — Webbing Tension Pull Device

5. Buckle Release Test

5.1 The release force of each buckle is to be tested after each dynamic test conducted with the heaviest ATD specified in subsection 2.4 for use in testing that restraint. The ATD must be retained in the restraint system and both forward- and rear-facing restraint systems installed in a forward-facing direction.

5.2 The buckle release force is to be tested as follows:

- (a) Tie a self-adjusting sling to the wrists and ankles of the ATD, as illustrated in Figure 4.
- (b) While applying a pullout force of 9 N to the buckle assembly in a direction that will produce maximum releasing effect, pull the sling horizontally and parallel to the SORL with a force of 50 N for a restraint system tested with the Newborn Infant ATD, subpart K, or 90 N for a restraint system tested with the CRABI 12-month-old infant ATD, subpart R.

Note: If the restraint system is equipped with a T-shield, a force equivalent to its mass shall be added to the pullout force. Any shield, if present, may be adjusted to facilitate application of the pullout force, provided that the harness tension is not significantly affected.

- (c) Apply a release force as per subsection 3.4 or 3.5, as applicable.

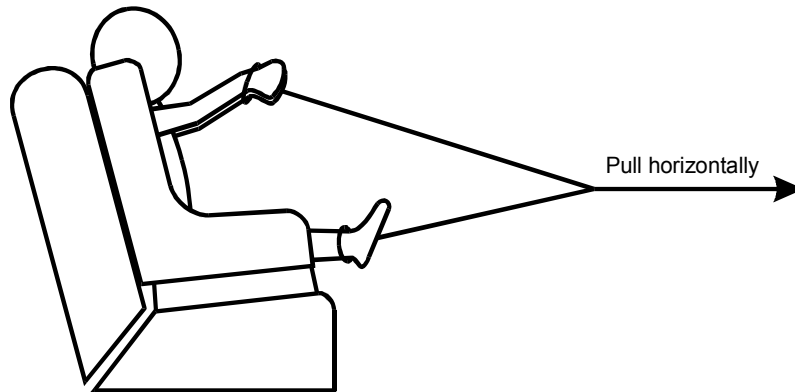


Figure 4 — Self-Adjusting Sling for the Buckle Release Test

6. Energy Absorbing Material Test

Prepare and test specimens of energy absorbing material in accordance with the applicable 25 % compression-deflection test described in one of the following ASTM International Standards:

- (a) *Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber*, Designation No. D1056-00;
- (b) *Standard Specification for Flexible Cellular Materials—Vinyl Chloride Polymers and Copolymers (Open-Cell Foam)*, Designation No. D1565-81 (Reapproved 1990); or
- (c) *Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams*, Designation No. D3574-08.

7. Inversion Test

7.1 Each infant restraint system shall meet and be tested in accordance with subsections 7.2 to 7.6 when adjusted in any seat back angle adjustment position and restraint belt routing position.

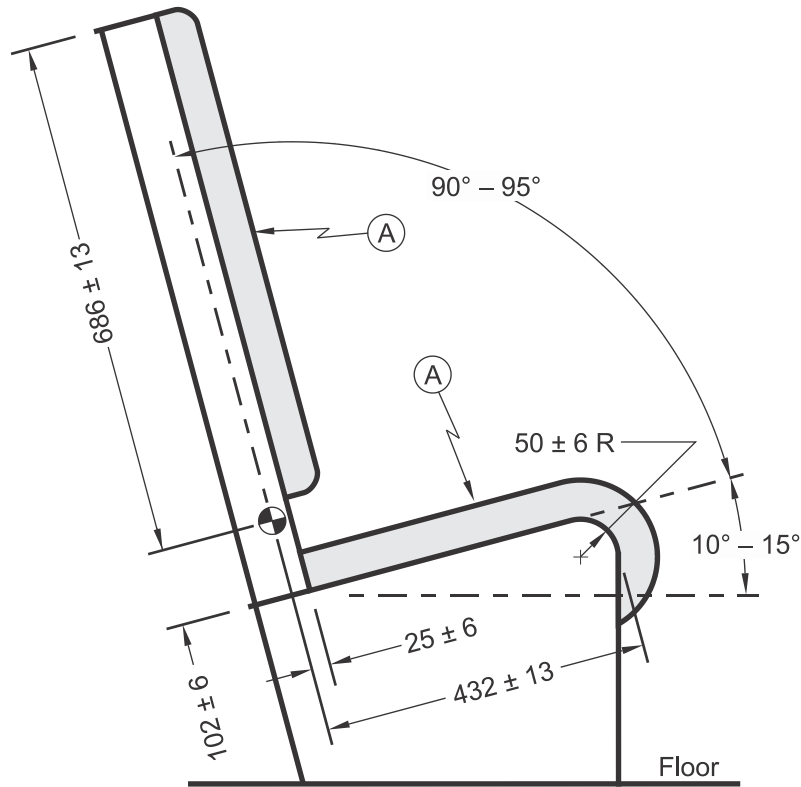
7.2 A representative aircraft passenger seat shall be positioned and adjusted so that its horizontal and vertical orientation and its seat back angle are as shown in Figure 5.

7.3 The infant restraint system shall be attached in accordance with the manufacturer's instructions to the representative aircraft passenger seat using, at the manufacturer's option, any aircraft safety belt approved by the U.S. Federal Aviation Administration or by Transport Canada's Director, Aircraft Certification. No supplementary anchorage belts or tether straps may be attached; however, safety belt extensions approved by the U.S. Federal Aviation Administration or by Transport Canada's Director, Aircraft Certification, may be used.

7.4 In accordance with the requirements of subsection 4.5.2, place and restrain the ATD specified in subsection 2.4 in the infant restraint system.

7.5 The combination of representative aircraft passenger seat, infant restraint system, and ATD shall be rotated forward around a horizontal axis that is contained in the median transverse vertical plane of the seating surface portion of the aircraft seat and is located 25 mm below the bottom of the seat frame, at a speed of 35° to 45° per second, to an angle of 180°. The rotation shall be stopped when it reaches that angle, and the seat shall be held in this position for three seconds. The specified rate of rotation shall be attained in not less than one-half second and not more than one second, and the rotating combination shall be brought to a stop in not less than one-half second and not more than one second.

7.6 Repeat the procedure set out in subsections 7.2 to 7.4. The combination of the representative aircraft passenger seat, infant restraint system, and ATD shall be rotated sideways around a horizontal axis that is contained in the median longitudinal vertical plane of the seating surface portion of the aircraft seat and is located 25 mm below the bottom of the seat frame, at a speed of 35° to 45° per second, to an angle of 180°. The rotation shall be stopped when it reaches that angle, and the seat shall be held in this position for three seconds. The specified rate of rotation shall be attained in not less than one-half second and not more than one second, and the rotating combination shall be brought to a stop in not less than one-half second and not more than one second.



Notes:

1. Dimensions in mm
2. Not to scale
3. A represents a 50-mm to 76-mm thick polyurethane foam pad with a density of 24 kg/m³ to 32 kg/m³, over a 0.50-mm thick aluminum pan and covered by marine canvas of 400 g/m² to 480 g/m².
4. The sheet aluminum pan is 508 mm wide and supported on each side by a rigid structure.
5. The seat back is a rectangular frame covered with an aluminum sheet whose mass is between 6.3 kg and 6.8 kg with a centre of mass 330 mm to 406 mm above the seat pivot axis.
6. The mass moment of inertia of the seat back about the pivot axis is between 1.38 kg-m² and 1.55 kg-m².
7. The seat back is free to fold forward about the pivot, but a stop prevents rearward motion.
8. The passenger safety belt anchor points are spaced from 533 mm to 559 mm apart and are located along the seat pivot axis.

Figure 5 — Simulated Aircraft Passenger Seat