



Seat and Head Restraint Energy Absorption Capability

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The purpose of this test procedure is to determine if the energy absorbing capability of the seat back and head restraints meets the requirements of:

- FMVSS 201
- CMVSS 201
- KMVSS Article 98
- ECE R 17
- ECE R 21
- ECE R 25

1.2 Applicability. This standard applies to all passenger cars, Multipurpose Passenger Vehicles (MPV), trucks and buses with a Gross Vehicle Weight Rating (GVWR) of 4536 kg (10 000 lb) or less. This specification does not apply to rearmost, side facing, back-to-back, folding auxiliary jump, and temporary seats.

1.3 Remarks. Seat backs and head restraints are subjected to a pendulum strike simulating the head impact in the case of an accident. The idea is to improve the occupant protection. Occupant impact protection must be addressed during the design stages of vehicle development. Therefore, the head impact area on seat backs and head restraints must be determined graphically from design layouts and details. This specification describes the method for determining impact areas and the test procedure to be used in evaluation occupant impact protection of seat backs and head restraints.

All values given in this test procedure were valid at the date of issue. For the actual values, refer to the newest editions of the standards listed in 2.1.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

CMVSS 201	ECE R 25	KMVSS Article 98	SAE J977
ECE R 17	FMVSS 201	SAE J211	SAE J984
ECE R 21	ISO 6487	SAE J921	

2.2 GM Standards/Specifications.

None

2.3 Additional References.

None

3 Resources

3.1 Facilities. An approved, GM certified test lab with an adequate bed plate or equivalent work surface necessary for mounting of the test sample and associated test fixtures.

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3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Layouts. Layouts and details showing the front seat back design as well as location of the Seating Reference Point (SgRP) of the rear Designated Seating Position (DSP).

3.2.2 Mounting Blocks. Rigid mounting blocks that simulate the floor attachment points and mount the seat subsystem in the body position on a bedplate or equivalent work surface.

3.2.3 Head Form. A rigid semi-sphere of 165 mm (6.5 in) diameter and 6.8 kg (15 lb) mass (Reduced Mass (Mr)).

Note: The relationship of the Reduced Mass (Mr) of the pendulum to the total mass "M" of the pendulum at a distance "A" between the center of percussion and the axis of rotation and at a distance "L" between the center of gravity and the axis of rotation is given by the formula:

$$Mr = M \times L/A$$

3.2.4 Head Impact Pendulum. Device to impact selected points on the seat back with the head form at 24.2 km/h (15 mph).

3.2.5 Camera. High speed cameras and lighting equipment to capture images as required.

3.2.6 Instrumentation. Instrumentation to measure head form velocity at impact and head form acceleration time history during impact equivalent to that specified in SAE J977 as follows:

3.2.6.1 Accelerometer. Two accelerometers shall be mounted to the head form interior to permit measurement of at least 80G. Acceleration shall stay within $\pm 5\%$ of the actual value. The frequency response of the accelerometer shall be consistent with the requirements of SAE J211 or class 600 corresponding to ISO 6487.

3.2.6.2 Displacement Transducer. It shall be capable of measuring the movement of the head form in the axial direction during test.

3.2.6.3 Recorder. It shall be capable of measuring acceleration at impact for at least 160 ms. Time step shall be at least 0.001 s, accuracy within $\pm 2.5\%$ of the actual value, and tolerance of 0.5 km/h.

3.2.6.4. Speed Measuring Device. A speed measuring device, capable of measuring values in the direction of impact has to be mounted in the head form (ECE R 17).

Note: All instrumentation is to be calibrated as required. Record instrumentation details and calibration date unless the information is otherwise preserved in the testing facility records.

3.3 Test Vehicle/Test Piece.

3.3.1 Complete Trimmed Seat Subsystem. An appropriate seat subsystem consisting of all the components necessary to qualify as complete for the model and trim level specified by the Design Release Engineer (DRE) or Designing Engineer (DE).

3.4 Test Time.

Calendar time:	1 day
Test hours:	< 1 hour
Coordination hours:	8 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. The following individuals are necessary to complete this test procedure:

3.6.1 GM Design Release Engineer.

3.6.2 GM Validation Engineer.

3.6.3 Testing organization's Test Engineer.

3.6.4 Testing organization's Test Technician.

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4 Procedure

4.1 Preparation.

4.1.1 Sample Inspection. The test engineers and requesting engineers should inspect the test time to ensure all material listed in 3.3 is of correct design level and assembled properly. Check for tears, abrasions, cracks, deformations, etc., and document any variation/deviation in assembly, etc.

4.1.2 Facilities and/or Equipment Preparation. Record the instrumentation calibration information on Appendix B, Data Sheet B1 or on an equivalent document.

4.1.3 Mount the complete trimmed seat subsystem on the appropriate rigid model mounting blocks. Include mounting spacers if specified for installation. Check the fastening torque of assembly nuts.

4.1.4 Adjustable seats shall be in their **Rearmost** design driving position and lowest adjusted position. Adjustable seat backs shall be in their **Nominal** design driving position (default for ECE R 17 is 25 degrees, if not otherwise noted). Head restraints shall be positioned at the least favorable position, generally the highest vertical adjustment position.

4.1.5 Close any interior compartment door assemblies located in a seat back. If they are lockable, the locking device shall be in an unlocked position.

4.1.6 Impact Test Area Determination. The impact area determination is a design procedure using three dimensional electronic procedures showing the relative location of the forward seat back, head restraint assembly, interior compartment door(s) and Seating Reference Point (SgRP). This procedure is written to determine the perimeter of the areas on the seat back within which impact determinations are to be made. See Appendix A, Figure A1 and Figure A2.

4.1.7 Locating the Measuring Device. At each rear designated seating position, place the pivot point of the measuring device at the SgRP.

4.1.8 Determining the Contact Points. With the pivot to "top-of-head" dimension at each value allowed by the device and the interior dimensions of the vehicle, determine all contact points on the seat back frame and frame components.

4.1.9 Determining Surface or Plane. With the head form at each contact point, and with the device in the vertical position if no contact point exists for a particular adjusted length, pivot the measuring device forward and downward through all arcs in vertical planes to 90 degrees each side of the vertical longitudinal plane through the SgRP, until the head form contacts an interior surface or until it is tangent to a horizontal plane 25 mm (1 in) above the SgRP, whichever occurs first.

4.1.10 Impact Zone.

4.1.10.1 FMVSS 201, CMVSS 201, KMVSS Article 98.

4.1.10.1.1 Seats with Head Restraints. Each test shall be conducted at points on the head restraint centerline of the head impact area as shown in Appendix A, Figure A3. Set the vertically adjustable head restraint to the lowest adjusted position.

4.1.10.1.2 Seats without Head Restraints. For each individual split bench or bucket seat, test shall be conducted each at points within 100 mm (4 in) left and right of its centerline. For a full bench seat, back test shall be conducted at points between 100 mm (4 in) outboard of the centerline of each outboard designated seating position as shown in Appendix A, Figure A4.

4.1.10.2 ECE R 17. The surfaces of the rear parts of seats to be checked are those situated in the areas defined below, which can be contacted by a 165 mm diameter sphere when the seat is mounted in the vehicle.

4.1.10.2.1 Area One (1).

4.1.10.2.1.1 In the case of separate seats without head restraints, this area shall include the rear part of the seat back between the longitudinal vertical planes situated at 100 mm on either side of the longitudinal median plane of the seat centerline, and above a plane perpendicular to the reference line 100 mm below the top of the seat back.

4.1.10.2.1.2 In the case of bench seats without head restraints, this area shall extend between the longitudinal vertical planes situated at 100 mm on either side of the longitudinal median plane of each designated outboard seating position defined by the manufacturer and above a plane perpendicular to the reference line 100 mm below the top of the seat back.

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4.1.10.2.1.3 In the case of seats or bench seats with head restraints, this area shall extend between the longitudinal vertical planes, on both sides of, and 70 mm from, the longitudinal median plane of the seat or of the seating position concerned and situated above the plane perpendicular to the reference line 635 mm from the R point. For the test, the head restraint, if adjustable, shall be placed in the least favorable position (generally the highest) permitted by its adjustment system.

4.1.10.2.2 Area Two (2).

4.1.10.2.2.1 In the case of seats or bench seats without head restraints and seats or bench seats with detachable or separate head restraints, Area Two (2) shall extend above a plane perpendicular to the reference line 100 mm distant from the top of the seat back, other than parts of Area One (1).

4.1.10.2.2.2 In the case of seats or bench seats with integrated head restraints, Area Two (2) shall extend above a plane perpendicular to the reference line 440 mm distant from the R point of the seat or of the seating position concerned, other than parts of Area One (1).

4.1.10.2.3 Area Three (3). Area Three (3) is defined as the part of the back of the seat or the bench seats situated above the horizontal planes defined in ECE R 17 (see 5.2.4.1.3 of ECE R 17), excluding parts situated in Area One (1) and Area One (2).

4.1.11 Radii Requirement (ECE R 17 only). The surface of the rear parts of seats shall exhibit no dangerous roughness or sharp edges likely to increase the risk of severity of injury to the occupants. This requirement is considered as satisfied if the surface of the rear parts of seats tested in the conditions specified in 4.3 exhibit radii of curvature not less than:

- 2.5 mm in Area One (1)
- 5.0 mm in Area Two (2)
- 3.2 mm in Area Three (3)

These areas are defined in 4.1.10.2.

4.1.11.1 This requirement does not apply to:

4.1.11.1.1 The parts of the different areas exhibiting a projection of less than 3.2 mm from the surrounding surface, which shall exhibit blunted edges, provided that the height of the projection is not more than half its width.

4.1.11.1.2 Rearmost seats and back-to-back seats.

4.1.11.1.3 Rear parts of seats situated below a horizontal plane passing through the lowest R point in each row of seats. (Where rows of seats have different heights, starting from the rear, the plane shall be turned up or down forming a vertical step passing through the R point of the row of seats immediately in front.)

4.1.11.1.4 Parts such as "flexible wire mesh".

4.1.11.2 In Area Two (2), surfaces may exhibit radii less than 5 mm, but not less than 2.5 mm provided that they pass the energy dissipation test prescribed in 4.3. Moreover, these surfaces must be padded to avoid direct contact of the head with the seat frame structure.

4.1.11.3 If the areas defined above contain parts covered with material softer than 50 Shore A hardness, the above requirements, with the exception of those relating to the energy-dissipation test in accordance with the requirements of ECE R 17 Annex six (6) shall apply only to the rigid parts.

4.1.12 Point of Impact.

4.1.12.1 FMVSS 201, CMVSS 201, KMVSS Article 98.

4.1.12.1.1 The points of impact shall be located on a line (maximum length of 840 mm (33 in)) tangent to the seat back frame. The origin of the line tangent to the seat back frame shall be on a point on a transverse horizontal line through the SgRP of the right rear Designated Seating Position (DSP).

4.1.12.1.2 Construct a perpendicular at the point of tangency. The intersection is the location of the point of impact. See Appendix A, Figure A5.

4.1.12.1.3 Inspect the seat back assembly within this area and select additional points which could be expected to give high deceleration on the head form at impact. The exact number of impacts required must be based on an engineering evaluation of the subject seat back assembly.

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