SAE INTERNATIONAL

SURFACE VEHICLE RECOMMENDED PRACTICE

J3026™ NOV2016

Issued 2014-08
Revised 2016-11

Superseding J3026 AUG2014

Ambulance Patient Compartment Seating Integrity and Occupant Restraint

RATIONALE

This revision includes clarification for bench seat testing to ensure a single or multi seat bench is tested in the same manner as a single, standalone captain's style seat. A reference to the Code of Federal Regulations, Title 49, Part 571.210 has been added to assist in determining when multiple anthropomorphic test devices should be used during a single test event. This revision also provides the ability for test facilities to utilize either the Hybrid III or ES2-re anthropomorphic test device for side impact testing relative to seated occupant's orientation.

1. SCOPE

This SAE Recommended Practice describes the testing procedures that may be used to evaluate the integrity of ground ambulance-based occupant seating and occupant restraint systems for workers and civilians transported in the patient compartment of an ambulance when exposed to a frontal or side impact. This Recommended Practice was based on ambulance patient compartment dynamics and is not applicable to other vehicle applications or seating positions. This Recommended Practice is structured to accommodate seating systems installed in multiple attitudes including but not limited to side-facing, rear-facing, and forward-facing. Its purpose is to provide ambulance seating manufacturers, ambulance occupant restraint manufacturers, ambulance builders, and end-users with testing procedures and, where appropriate, acceptance criteria that, to a great extent ensures the occupant seating and occupant restraint system meet similar performance criteria as FMVSS 208 requires for seat belted passengers in light vehicles. The test conditions utilized are standardized orientations that do not reflect potential conditions that may exist prior to impact such as braking and/or steering and their effects on the initial positions of the occupants and surfaces relative to the occupants. Descriptions of the test set-up, test instrumentation, photographic/video coverage, text fixture, and performance metrics are included.

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2. REFERENCES

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J211-1 Instrumentation for Impact Test - Part 1: Electronic Instrumentation

SAE J211-2 Instrumentation for Impact Test - Part 2: Photographic Instrumentation

SAE Engineering Aid 23"Users' Manual for the 50th-Percentile Hybrid-III Test Dummy," June 1985

SAE J2917 Occupant Restraint and Equipment Mounting Integrity – Frontal Impact Ambulance Patient Compartment

SAE J2956 Occupant Restraint and Equipment Mounting Integrity – Side Impact Ambulance Patient Compartment

SAE J3044 Occupant Restraint and Equipment Mounting Integrity – Rear Impact Ambulance Patient Compartment

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 Code of Federal Regulations (CFR)

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

Code of Federal Regulations, Title 49, Part 571.207.

Code of Federal Regulations, Title 49, Part 571.208.

Code of Federal Regulations, Title 49, Part 571.209.

Code of Federal Regulations, Title 49, Part 571.210

Code of Federal Regulations, Title 49, Part 571.213.

Code of Federal Regulations, Title 49, Part 571.214.

Code of Federal Regulations, Title 49, Part 572.

3. DEFINITIONS

3.1 DESIGNATED SEATING POSITION

As defined in 49 CFR 571.3 and 571.10, as applicable. This also includes any factory-installed built-in child restraint system as defined in 49 CFR 571.213.

3.2 PEDESTAL SEATING SYSTEM

A seating system that has restraint systems integrated into the seat's structure or attached to the seat's pedestal.

3.3 BENCH OR JUMP SEATING SYSTEM

A seating system that is built into, or integrated into, the patient compartment structure and may utilize portions of vehicle wall structure as the seat back. The restraint systems for these seats are attached to the vehicle wall or floor structure, seat base structure, or both, depending upon the restraint system utilized.

3.4 ANTHROPOMORPHICHYBR TEST DEVICE (ATD)

A biofidelic test device which represents a variety of human forms and sizes including men, women, and children. For the purposes of this document only 50th percentile male ATDs will be used, with a seated hip, to allow the ATD to be positioned properly on each seating system. Specific details regarding these ATD's are provided in 49 CFR Part 572. In the case of an integrated child seating position being tested, the instrumented ATD described in FMVSS 213 used should meet or exceed the maximum weight limits specified for that child seating position by the seat manufacturer for that designated child seating position.

3.5 RESTRAINT SYSTEM

Any strap, webbing, or similar device designed to secure a person in the patient compartment with the intention of mitigating the results of a collision, including all buckles and other fasteners and all hardware designed for installing the assembly in the ambulance patient compartment. The entirety of the restraint system shall meet the definitions set forth as "Occupant Restraint System" in 49 CFR Part 571.209.

3.6 FRACTURE

To crack or tear.

3.7 SEAT ADJUSTER

As defined by Title 49 CFR Part 571.207 means the part of the seat that provides forward and rearward positioning of the seat bench and back, and/or rotation around a vertical axis, including any fixed portion, such as a seat track.

3.8 SEATING SYSTEM

Any unique combination of a Bench, Jump, or Pedestal Seat, Restraint System, and Seat Adjuster which are used as a Designated Seating Position.

3.9 SEAT

A structure that provides at least one Designated Seating Position consisting of a minimum of a seat bench and may also include a back.

3.10 EXTENDED

The seat has been adjusted as far as possible on the seat base in the direction that the seated occupant is facing.

3.11 RETRACTED

The seat has been adjusted as far as possible on the seat base in the direction opposite that to which the seated occupant is facing.

4. REQUIREMENTS

Each patient compartment Seating System shall meet the requirements set forth under this recommended practice when tested in accordance with test conditions and procedures outlined in SAE J2917, Occupant Restraint and Equipment Mounting Integrity – Frontal Impact Ambulance Patient Compartment, SAE J2956, Occupant Restraint and Equipment Mounting Integrity – Side Impact Ambulance Patient Compartment and SAE J3044, Occupant Restraint and Equipment Mounting Integrity – Rear Impact Ambulance Patient Compartment.

4.1 Each Seating System shall be tested using one of the two following methods:

4.1.1 The Pedestal Seating System shall be mounted to a rigid sled device utilizing the mounting hardware locations and type(s) (e.g., number and type of fastener) prescribed by its manufacturer). The sled shall be capable of reproducing the crash pulse curves described in SAE J2917, Occupant Restraint and Equipment Mounting Integrity – Frontal Impact Ambulance Patient Compartment, SAE J2956, Occupant Restraint and Equipment Mounting Integrity – Side Impact Ambulance Patient Compartment and SAE J3044, Occupant Restraint and Equipment Mounting Integrity – Rear Impact Ambulance Patient Compartment.

4.1.2 The Bench or Jump Seating System shall include representative structure sufficient to fully attenuate ATD driven loading during performance of the sled test. If the bench seat has multiple designated seating positions, as described in FMVS 210 S4.2.4 (a) and (b), an ATD must be placed in each designated seating position at the same time and tested as a complete seating system. The Bench or Jump Seating System and representative structure shall be mounted to a rigid sled device. The sled shall be capable of reproducing the crash pulse curves described in SAE J2917, Occupant Restraint, Equipment Mounting Integrity – Frontal Impact Ambulance Patient Compartment and SAE J2956, Occupant Restraint and Equipment Mounting Integrity – Side Impact Ambulance Patient Compartment and SAE J3044, Occupant Restraint and Equipment Mounting Integrity – Rear Impact Ambulance Patient Compartment.

4.2 The Seating System may fracture but must maintain a continuous load path from the ATD, through the restraint system and the seating system structure, to the seating system's attachment to the floor or sled during the performance of each dynamic test.

4.3 ATD measured and calculated biomechanical parameters shall not exceed the following limits:

4.3.1 Forward- or rear-facing 50th percentile adult male Hybrid III ATD relative to the impact as specified in FMVSS 208.

4.3.2 Side-facing 50th percentile adult male ES-2re ATD relative to the impact as specified in FMVSS 214.

4.3.3 Side-facing 50th percentile adult male Hybrid III ATD relative to the impact as specified below:

4.3.3.1 The maximum calculated HIC36 value shall not exceed 1000.

4.3.3.2 The resultant acceleration calculated from the output of the thoracic instrumentation shall not exceed 60 g's, except for intervals whose cumulative duration is not more than 3 milliseconds.

NOTE: The recommended ATD for perpendicular impact relative to seating orientation for an adult occupant is the 50th percentile male ES-2re. However, if it suits the purposes of the test, the 50th percentile male Hybrid III may be substituted.

4.3.3.3 Forward- or rear-facing child ATD relative to the impact as specified in FMVSS 213, Child ATD excursion measurements are not required.

4.4 Occupant restraints must all be able to release at the buckle following each test event.

4.5 Damage or measured data values that result as an artifact of the test device or test procedure may be excluded from consideration. ATD-to-ATD contact may be excluded from consideration if multiple test devices are used as described in 4.1.2. A decision to exclude data from consideration shall be documented with an explanation that includes photographic and instrumented time history data to validate such as an artifact.

5. TEST CONDITIONS

The following conditions apply:

5.1 The rigid sled test platform shall be in a horizontal plane.

5.2 Each seating system shall be tested in each of the following positions:

5.2.1 A seating system facing the front of the vehicle shall be tested in the fully extended position using SAE J2917.

5.2.2 A seating system facing the rear of the vehicle shall be tested in the fully retracted position using SAE J2917. This test is specifically intended to evaluate the integrity of the seating system in this position.

5.2.3 A seating system facing the rear of the vehicle shall be tested in the fully extended position using SAE J2917. This test is specifically intended to evaluate the integrity of the seating system and seat adjuster in this position

5.2.4 A seating system facing the front or rear of the vehicle that is symmetrical shall be tested with the seat in the fully extended position using SAE J2956.

5.2.4.1 If the forward or rear facing seating system is asymmetrical, two tests must be completed to evaluate the asymmetrical loading imparted on the ATD and seating system, once on each side, in the fully extended position, using SAE J2956.

5.2.5 A seating system that is only lockable in a side facing position relative to the front of the vehicle shall be tested in both the full extended and fully retracted adjustable position using SAE J2956.

5.2.5.1 The Seating System shall be tested with the SAE J2956 impact directed into the front of the occupant with the seating system in the fully extended position to test seat structural integrity, occupant restraint structural integrity, and ATD response when the ATD is directed into the restraint system.

5.2.5.2 The Seating System shall be tested with the SAE J2956 impact pulse directed into the rear of the occupant seat or Bench Seat with the seat system in the fully retracted position to test seat structural integrity, occupant restraint structural integrity, and ATD response when the ATD is directed into the seat back or padded wall structure.

5.2.6 All other lockable positions from +90 through 0 degrees to -90 degrees, where 0 degrees points toward the front of the vehicle, shall be tested with the seat in the fully extended adjustable position using SAE J2917.

5.2.7 All other lockable positions from +91 through 180 degrees to -91 degrees, where 180 degrees points toward the rear of the vehicle, shall be tested with the seat in the fully retracted adjustable position using SAE J2917.

5.2.8 A seating system that is only to be installed rear facing may be tested into the restraint system utilizing SAE J3044.

5.3 These tests are considered destructive tests. Therefore, a new seating system shall be used in each test attitude.

5.4 The ATD to be used will vary based on seating orientation and seat application. Select the appropriate ATD for a given test based on the following criteria;

5.4.1 Any designated seating position designed for an adult with a locked, perpendicular orientation relative to the direction of impact shall use either the 50th percentile adult male Hybrid III ATD or the 50th percentile adult male ES-2re ATD instrumented in accordance with the requirements described in paragraphs 4.3.2 or 4.3.3, respectively.

5.4.2 Any designated seating position designed for a child, with a locked, perpendicular orientation relative to the direction of impact, shall use the largest ATD described in FMVSS 213 applicable to the maximum height and weight rating of the child restraint.

5.4.3 For all other orientations, the ATD described in FMVSS 208, or 213 as applicable, shall be used.

5.5 Uni-axial accelerometers shall be installed on rigid structure within 5 inches of both the fore and aft seat attachment points oriented in line with the primary axis for each test. At least one tri-axial accelerometer shall be installed on the seat and seat mounting structure oriented in line with the primary axis for each test.

5.6 The general guidelines of SAE J211 should be followed for sensor orientation, filter frequencies and sampling rate. The revision of each SAE standard in effect at the time of testing will be utilized.

5.7 High-speed video (either color or black and white) and real time video will be used to document each test. A minimum of 2 high speed video imagers will be used to record the motions of the ATD and seat during each test. Additional cameras may be required to ensure full field of view coverage.

5.8 Timing marks shall be provided and synchronized to a common strobe-type flash or other means to allow synchronization of all visual and electronic data.

5.9 Color still photographs shall be taken to document the pre- and post-test conditions of the test articles (seating system and ATD) for each test.

6. TEST PROCEDURES

6.1 Complete all pre-test checklist items identified in Appendix 1, as appropriate.

6.2 The seating system shall be installed on a rigid test platform per manufacturer's provided instructions.

6.3 Place instrumented ATD on Seating System and secure per seat and restraint manufacturer's requirements and in accordance with 49 CFR Part 571.208, 49 CFR Part 571.213 or 49 CFR Part 571.214, as appropriate. Emergency locking retractors (ELR) shall not be locked prior to the test.

6.4 Instrument each Seating System per the applicable requirements of Appendix 1.

6.5 Pretest photos will be taken to document location of the ATD and restraint systems as described in Appendix 1.

6.6 Test in accordance with dynamic sled test facility protocol to achieve dynamic loading as defined in SAE J2917 and SAE J2956, respectively.

6.7 Verify proper recording of instrumented data within the data acquisition system. Recording of all ATD channels shall be accomplished in accordance with the requirements of FMVSS 208, 213, and 214 as applicable. Should a Hybrid III be used in lieu of the ES-2re, instrumentation requirements described in 4.3.3 shall apply.

7. POST TEST INSPECTION

7.1 Complete all post-test checklist items identified in Appendix 1, as appropriate.

7.2 Inspect Restraint System for evidence of tearing of webbing or stitching. Any instances should be noted in the report through photos.

7.3 Inspect Seating System for evidence of material fracture and deformation.

7.4 Photos will be taken to define post-test position of ATD in accordance with 49 CFR 571.208, 49 CFR 571.213 and 49 CFR 571.214, respectively.

8. NOTES

8.1 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE TRUCK CRASHWORTHINESS COMMITTEE

APPENDIX A - (SLED TEST CHECK LIST)

	Pre Test	Comment	Complete
1.0	Verify laboratory conditions – temperature and humidity		
2.0	Configure sled system for required test pulse and perform calibration shots as necessary	Check Acceleration and Velocity to ensure it is within the corridor. Determine if another calibration run is needed.	
3.0	Gather required tools – check and record calibration information and serial numbers	Per manufacturer's specifications and test standard requirements	
4.0	Gather required instrumentation – check and record calibration information and serial numbers	Per manufacturer's specifications and test standard requirements	
5.0	Ensure ATDs are calibrated and contain the necessary calibrated instrumentation record serial numbers	Per manufacturer's specifications and test standard requirements	
6.0	Install instrumentation to record loading at floor level (if required)	At the discretion of seating manufacturer.	
7.0	Weigh test article and record weight and serial number		
8.0	Assemble and attach test article to the sled as directed by the manufacturer's instructions		
9.0	Adjust the seat to the test position (e.g., full forward on seat track)		
10.0	Conduct an H-point measurement, if necessary	Per standard	
11.0	Install instrumentation onto restraint system to measure loading (Required if intended to be installed on vehicle wall structure.)	If requested by seat or restraint manufacturer when installed directly on a seating system.	
12.0	Install any additional instrumentation onto the seat as directed by the manufacture or test witness		
13.0	Tension ATD's joints to a 1G tension		

	Pre Test	Comment	Complete
14.0	Position the ATD in the seat	per manufacturer's direction and test standard	
15.0	Install the restraint system around the ATD		
15.1	Manually adjusted restraints should be pulled snuggly to ATD		
15.2	ELRs shall be in the unlocked position		
16.0	Sign convention shall be relative to the vehicle orientation.	Per SAE J211	
17.0	Tether ATD and seat to sled – ensure enough slack to not interfere with test		
18.0	Mark seat track slider and restraint adjustments, mark belts for slippage, retractor setup to measure payout	Will be used for post-test analysis of movement. Place a marking on each restraint at each webbing adjuster and at one inch increments for a total of six inches.	
19.0	Setup data system, ensure all channels are collecting properly, ensure trigger works		
20.0	Setup high speed video, ensure proper coverage for headpaths and test to ensure trigger works	Must be able to obtain X, Y, and Z direction occupant envelope from video coverage	
21.0	Ensure no extra tools/hardware/items not to be tested are still on the sled		
22.0	Take pre-test photos	Provide photo and/or comment to all listed items: (Photos will be taken to define pre-test position of ATD in accordance with 49 CFR 571.208, CFR 571.213 and 214, respectively.)	
22.1	Overall of test setup from front, sides, and rear		
22.2	Positioned ATD in seat/restraint system		
22.3	Restraint system		
22.4	Accelerometer locations, if any		

	Pre Test	Comment	Complete
22.5	Serial number(s) close up		
23.0	Arm video and data system		
24.0	Verify all personnel in sled facility are in a safe area		
25.0	Pre-test confirmation	Requesting and test body signoff	
26.0	Conduct Sled Test		
	Post Test	**Comment**	**Complete**
1.0	Photos	Provide photo and/or comment to all listed items: Photos will be taken to define post-test position of ATD in accordance with 49 CFR 571.208, CFR 571.213 and 214, respectively.	
1.1	Overall of test setup from front, sides, and rear		
1.2	Positioned ATD in seat/restraint system		
1.3	Restraint system		
1.4	Close up of any fractured, deformed, components		
2.0	Visual inspection of deformation, fracture, and tear	Document and comment on the continuity of the load path for the Seating System.	
3.0	Restraint system	Check if ATD's restraint system remained buckled during test and check if buckle will release post-test. Record belt payout."	
4.0	Detached components	Review film for any loose components.	
5.0	Exposed sharp components	Document and comment location(s)	
6.0	Remove test article from sled to conduct a more in-depth inspection of seat, restraint, and attaching hardware		

	Post Test	Comment	Complete
7.0	Pulse verification	Check if pulse met target corridor	
8.0	ATD Injury Analysis	Compare recorded injuries values to test standard requirements	