SAE INTERNATIONAL

SURFACE VEHICLE RECOMMENDED PRACTICE

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Ambulance Patient Compartment Structural Integrity Test to Support SAE J3027 Compliant Litter Systems

RATIONALE

This SAE Recommended Practice was developed by members of the SAE Truck Crashworthiness Committee in support of the ambulance industry's need to apply science to the design and testing of the ambulance substructure to support the safe mounting of SAE J3027 compliant litter retention devices or systems used in the ambulance patient compartment. The Recommended Practice was validated collaboratively by industry and government partners through extensive testing funded and managed by the National Institute for Occupational Safety and Health, the Department of Homeland Security and the Ambulance Manufacturers Division of the NTEA. Input loading for the dynamic testing was generated using the vehicle specific crash pulses described in SAE J2917, SAE J2956, and SAE J3044, respectively. An independent analysis of the testing methodology and resulting data was performed by government and private members of the automotive testing community.

1. SCOPE

This SAE Recommended Practice describes the dynamic and static testing procedures required to evaluate the integrity of the ambulance substructure, to support the safe mounting of an SAE J3027 compliant litter retention device or system, when exposed to a frontal, side or rear impact (i.e., a crash impact). Its purpose is to provide manufacturers, ambulance builders, and end-users with testing procedures and, where appropriate, acceptance criteria that to a great extent ensure the ambulance substructure meets the same performance criteria across the industry. Prospective manufacturers or vendors have the option of performing either dynamic testing or static testing. Descriptions of the test set-up, test instrumentation, photographic/video coverage, test fixture, and performance metrics are included.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.2 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

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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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 J3027 Ambulance Litter Integrity, Retention, and Patient Restraint

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

2.3 Related Publications

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

2.3.1 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 572

3. DEFINITIONS

3.1 DYNAMIC AMPLIFICATION FACTOR: The dynamic amplification factor is a multiplier used to convert the peak dynamic load to an equivalent static load.

3.2 SYSTEM WEIGHT: The weight of the litter, litter retention device, or system plus the Hybrid III 50th percentile male estimated at 77.6 kg ± 1.2 kg (171.3 pounds ± 2.6 pounds) as described in the Code of Federal Regulations, Title 49, Part 572, Subpart E. (To represent the weight of a 50th percentile male patient.)

3.3 LITTER: A wheeled patient transport device affixed using a litter retention device or system. This does not include wheelchairs, stair chairs, transport chairs, backboards, incubator transport cots, or carry stretchers.

3.4 LITTER RETENTION DEVICE OR SYSTEM: A retention system that utilizes a temporary or permanent means of fixation, which may have fixed or adjustable positions. Also includes all hardware provided for holding the intended device.

3.5 FRACTURE: Cracking or tearing of the substructure or mounting hardware.

3.6 LOAD BEARING: Any component of the substructure or mounting hardware that is required to maintain the litter retention device or system in a secured position.

3.7 LOAD PATH: A series of load bearing components.

3.8 MOUNTING HARDWARE: Fasteners and other associated components that are used to affix a litter retention device or system to the interior of an ambulance structure.

3.9 PEAK ACCELERATION: The maximum “g” loading for the applicable pulse corridor as described in SAE J2917, SAE J2956, or SAE J3044, respectively.

3.10 DYNAMIC TEST ANALOG/DEVICE: A rigid inert structure that represents the physical dimensions, weight and center of gravity in all axes of the litter, 50th percentile male patient (77.6 kg or 171 pounds), and Litter Retention Device or System. It provides connection points to attach to the substructure of the patient compartment of the ambulance that match those found on the actual hardware to be mounted, as recommended by the litter retention device or system manufacturer. Where contact surfaces such as wheels or outriggers are present, they should also be represented on the analog. An actual production litter and test dummy (instrumentation optional), fitting the criteria defined in SAE J3027 definitions 3.1 to 3.4, installed in accordance with SAE J3027 Test Procedures 6.1 to 6.4.3.11 and 6.6 may be used in lieu of the rigid test fixture. This analog or device does need to match the system weight and center of gravity of the litter, 50th percentile male, and litter retention device or system.

3.11 STATIC TEST ANALOG/DEVICE: A rigid inert structure that is used to apply loads to the substructure in a manner which is consistent with the litter retention device or system. It provides connection points to attach to the Substructure of the patient compartment of the ambulance that match those found on the actual hardware to be mounted, as recommended by the litter retention device or system manufacturer. Where contact surfaces such as wheels or outriggers are present, they should also be represented on the analog. The analog or device must allow the quasi static applied load being applied to it to pass through the theoretical center of gravity represented by the system weight. This analog or device does not need to match the weight of the litter, 50th percentile male, and litter retention device or system.

3.12 QUASI STATIC APPLIED LOAD (QSAL): The load to be applied in the static test of an equipment mounting device or system in lieu of a dynamic test. The QSAL is defined mathematically as the system weight times the peak acceleration times the dynamic amplification factor.

3.13 SUBSTRUCTURE (also known as ambulance substructure): The patient compartment framing or load bearing material that is used to anchor the litter retention device or system.

4. DYNAMIC TEST REQUIREMENTS

The ambulance substructure and dynamic test analog/device shall be tested using the pulse corridors defined in SAE J2917, SAE J2956, and SAE J3044, respectively. The ambulance substructure and dynamic test analog/device will then be evaluated in accordance with Section 8.

5. DYNAMIC TEST CONDITIONS

The following conditions apply:

5.1 Due to the large number of mounting locations for each mounting device or system, a rigid sled test fixture shall be used. For example, a horizontal surface would represent an ambulance floor while a vertical surface would represent an ambulance wall.

5.2 These tests are considered destructive therefore, deformation and fracture shall be expected and considered acceptable within the criteria of Section 8. At the option of the manufacturer, a new ambulance substructure and dynamic test analog/device may be used in each test attitude.

6. DYNAMIC TEST PROCEDURES

The litter retention device or system manufacturer is responsible for determining all recommended product or product mount orientations relative to the patient compartment of the ambulance.

6.1 Install the ambulance body or substructure to the sled device.

6.1.1 For all modular ambulance patient compartments, install the ambulance substructure directly to the sled device as prescribed in the ambulance manufacturer’s instructions or recommendations. Preservation of the mount design intent must be maintained in order to replicate performance when mounted on an ambulance chassis.

6.1.2 For Type II or a uni-body ambulance patient compartment, a representative original equipment manufacturer (OEM) structure must be utilized. The OEM structure, with structural enhancements produced by the ambulance builder, shall be mounted directly to sled device as prescribed in the OEM body builder’s manual. Preservation of the mount design intent must be maintained in order to replicate performance when mounted on an ambulance chassis.

6.2 Install dynamic test analog/device per instructions provided by the ambulance manufacturer and as recommended by the Litter Retention Device or System manufacturer.

6.3 Test in accordance with dynamic sled test facility protocol to achieve dynamic loading as defined in SAE J2917, SAE J2956, and SAE J3044, respectively.

7. POST DYNAMIC-TEST INSPECTION

7.1 Inspect the substructure and analog mounting hardware for evidence of material fracture and deformation. Any instances of deformation or fracture should be noted in the report through photos. Parts breaking free from the substructure should also be documented through photos and noted in the report.

7.2 It should be noted if the dynamic test analog/device was retained in the substructure.

7.3 It should be noted if the ambulance substructure remained fastened to the sled test fixture or surface.

8. DYNAMIC TEST ACCEPTANCE CRITERIA

The following acceptance criteria are applied per Section 4 to determine the “pass” or “fail” state of the test.

8.1 If an actual production litter and test dummy is used, then the acceptance criteria delineated in SAE J3027 8.1 to 8.4 shall also apply.

8.2 Deformation and displacement of the ambulance substructure, mounting hardware, and dynamic test analog/service is acceptable.

8.3 Fracture of the substructure is acceptable, as long as a load path is maintained.

8.4 The ambulance substructure must remain attached to the sled.

8.5 Data resulting from instrumentation installed per a manufacturer’s request will NOT be a part of the pass/fail criteria associated with this testing procedure.

9. STATIC TEST REQUIREMENTS

If an ambulance manufacturer chooses the option to perform static tests on the substructure to anchor a litter retention device or system, the substructure and retention hardware shall be tested to the quasi-static applied load (QSAL) calculated as follows:

QSAL = System Weight x Peak Acceleration x Dynamic Amplification Factor

The test shall be performed utilizing the QSAL for each impact direction for the intended litter installation orientation. Table 1 provides examples based on system weight of 227 kg (500 pounds). The ambulance substructure with the static test analog/device will then be evaluated in accordance with Section 13.

Table 1

Pulse Direction	SAE Reference Document	System Weight	Peak Acceleration	Dynamic Amplification Factor	QSAL
Front	SAE J2917	227 kg (500 pounds)	22.5 G	1.5	75064 N (16875 pounds)
Side	SAE J2956	227 kg (500 pounds)	26.0 G	1.5	86740 N (19500 pounds)
Rear	SAE J3044	227 kg (500 pounds)	10.0 G	1.5	33362 N (7500 pounds)

10. STATIC TEST CONDITIONS

The following conditions apply:

10.1 Due to the large number of mounting locations for each mounting device or system, a rigid test fixture shall be used. For example, a horizontal surface would represent an ambulance floor while a vertical surface would represent an ambulance wall.

10.2 These tests are considered destructive, therefore, deformation and fracture is considered acceptable within the criteria of Section 13. At the option of the manufacturer a new ambulance substructure and litter retention device or system may be used in each test attitude.

11. STATIC TEST PROCEDURES

The litter retention device or system manufacturer is responsible for determining all recommended product or product mount orientations relative to the patient compartment of the ambulance. The ambulance substructure and litter retention hardware shall be capable of meeting the requirements of Section 9.

11.1 Install the ambulance body or substructure directly to the rigid test surface as prescribed in the ambulance manufacturer's instructions or recommendations.

11.1.1 For all modular ambulance patient compartments, install the ambulance substructure directly to the rigid test surface as prescribed in the ambulance manufacturer's instructions or recommendations. Preservation of the mount design intent must be maintained in order to replicate performance when mounted on an ambulance chassis.

11.1.2 For Type II or a uni-body ambulance patient compartment, a representative OEM structure must be utilized. The OEM structure, with structural enhancements produced by the ambulance builder, shall be mounted directly to rigid test surface as prescribed in the OEM body builder's manual. Preservation of the mount design intent must be maintained in order to replicate performance when mounted on an ambulance chassis.

11.2 Install static test analog/device per instructions provided by the ambulance manufacturer and as recommended by the litter retention device or system manufacturer.

11.3 Attach a cable, chain or other appropriate attachment for the load being applied with a calibrated in-line gauge or load cell to the static test analog/device at a point representing the center of gravity and it shall be oriented on a horizontal plane with the cg of the static test analog/device with a pitch tolerance of ±4° and a yaw tolerance of ±3°.

11.4 For all quasi-static test cases, the peak quasi-static applied load (QSAL) shall be calculated as follows:

QSAL = System Weight x Peak Acceleration x Dynamic Amplification Factor

EXAMPLE 1: Figure 1 is the top view of an ambulance and is showing a litter system mounted on the floor of the ambulance in a longitudinal orientation. The three static test QSAL shall then be calculated and applied as depicted below to represent frontal (SAE J2917), side (SAE J2956), and rear (SAE J3044) impacts, independently.

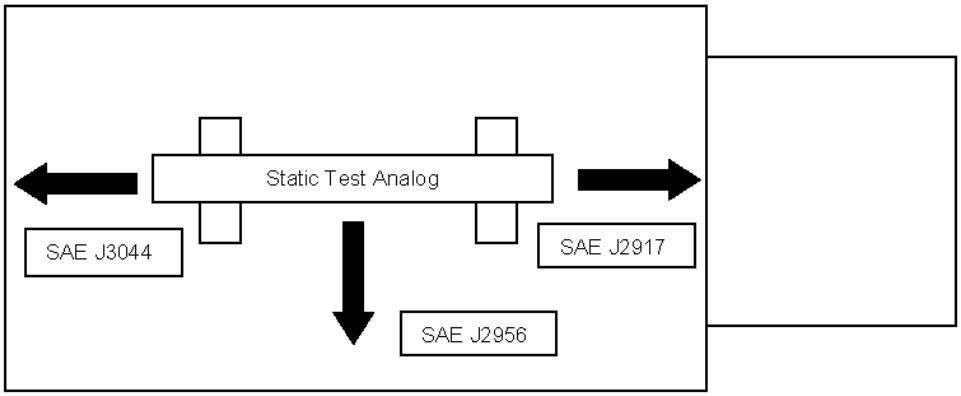

Figure 1

EXAMPLE 2: Figure 2 is the top view of an ambulance and is showing a litter system mounted on the floor of the ambulance in a lateral or side load orientation. The three static test QSAL shall then be calculated and applied as depicted below to represent frontal (SAE J2917), side (SAE J2956), and rear (SAE J3044) impacts, independently.

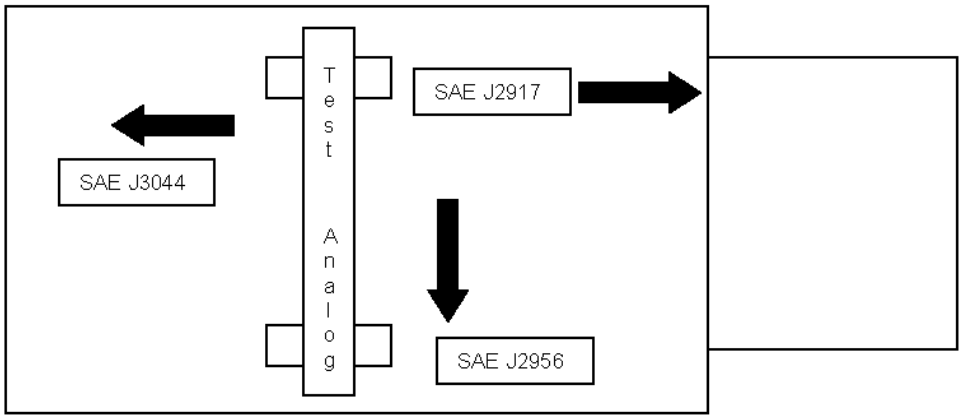

FIgure 2

11.5 Apply the load to the static test analog/device until a 5% preload is achieved. Inspect the test fixture for safety prior to increasing the load.

11.6 Apply load to achieve the QSAL at an average rate of no less than 68 kg/s (150 lb/s) and no greater than 454 kg/s (1000 lb/s). When the QSAL has been attained; hold that load for a minimum of 10 seconds.

11.7 Release applied load, to achieve 0 kg (0 pounds) in no more than 10 seconds.

11.8 Record the maximum quasi static applied load and load rate.

12. POST STATIC-TEST INSPECTION

12.1 Inspect the substructure and analog mounting hardware for evidence of material fracture and deformation. Any instances of deformation or fracture should be noted in the report through photos. Parts breaking free from the substructure should also be documented through photos and noted in the report.

12.2 It should be noted if the test analog/device was retained in the substructure.

12.3 It should be noted if the ambulance substructure remained fastened to the test fixture or surface.

13. STATIC TEST ACCEPTANCE CRITERIA

The following acceptance criteria are applied per Section 9, to determine the “pass” or “fail” state of the test.

13.1 Deformation and displacement of the ambulance substructure, litter retention hardware and analog device is acceptable.

13.2 Fracture of the substructure is acceptable as long as a load path is maintained.

13.3 The ambulance substructure must remain attached to the test fixture or surface.

13.4 Data resulting from instrumentation installed per a manufacturer’s request will NOT be a part of the pass/fail criteria associated with this testing procedure.

14. NOTES

14.1 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.

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THE TRUCK AND BUS BODY AND OCCUPANT ENVIRONMENT STEERING COMMITTEE