

Presentation Outline

Kevin Gallagher, NRP

- **Ambulance Crash Data**
- **The Ambulance Environment**
 - History and Development
 - Issues and Concerns With Current Ambulance Design
- **Developing New Testing Methods and Standards**
 - Ambulance specific test pulses
 - New Standards Developed To Date
 - Review of Cot Standard
 - Review of Seating Standard
 - Review of Equipment Standard
- **Implementing New Standards and Testing**
- **Considerations For Incorporating New Standards Into Ambulance Design**
- **Pediatric Considerations**

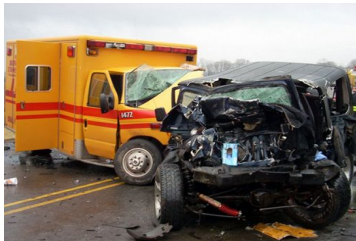
Acknowledgements

Crash test videos and supporting information provided by the National Institute for Occupational Safety and Health, Division of Safety Research, Morgantown, WV

Special Thanks To Jim Green
National Institute for Occupational Safety and Health
Division of Safety Research

Ambulance Crash Data

- According to NHTSA data from 1992 to 2011, there is an estimated mean of 4,500 Ambulance crashes annually
- Those crashes include 2,600 injuries and 33 fatalities
- According to CDC data, over 79% of ambulance crashes are from the front
- One in ten (~6 million) ambulance transports involves pediatric patient



The Ambulance Environment

- EMS has developed with a speed unprecedented in the health professions
- EMS's needs for more space and equipment and the rapid growth from automobile based vehicles to current modular designs has outpaced the development of standards and testing
- Included with other commercial vehicles under FMVSS, the rear compartment is not addressed by the FMVSS standards.



The Ambulance Environment

- Available seating is usually either side or rear facing
- Restraints vary and may be lap belts or mounted in non-standard locations
- Attendants frequently unrestrained
- Many edges, corners, and protruding objects
- Equipment may be loose or stored on shelves or in cabinets
- Cots, cot mounts and restraints may not be adequate in a crash



Structural Concerns with Existing Litter Retention Devices & Seating Systems



Frontal Crash: 30 mph into a rigid wall
This is the same test used in passenger vehicles

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Occupant Excursion Issue: Existing Restraint Type and Location

Pre-crash event:
standard cot,
restraint and antler
floor fastener



Mid-crash event:
patient excursion
exceeds 30 inches or
76 cm

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Structural concerns with existing seats when used differently than designed & tested



Frontal Crash @ 30 mph: This is the same test used in
passenger vehicles

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Concerns With Unsecured Ambulance Equipment and Supplies



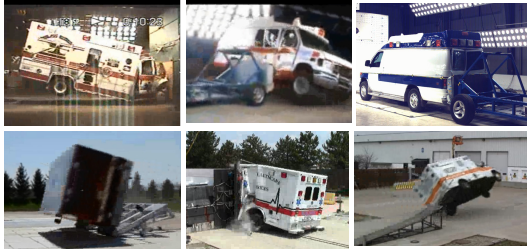
Prior to crash equipment and gurney
either mounted or stowed in cabinets



Post crash (rollover) equipment and
gurney positions drastically changed

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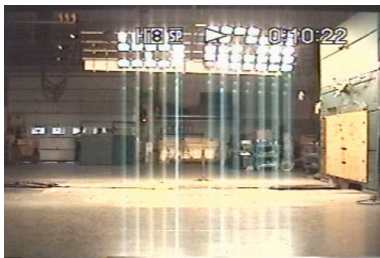
Building New Ambulance Test Methods: The Foundation is Crash Testing



Crash testing helps us understand how the vehicle reacts both internally and externally as crash energy is distributed.

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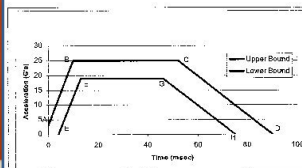
Building New Ambulance Test Methods: Must be relevant to ambulance crash characteristics



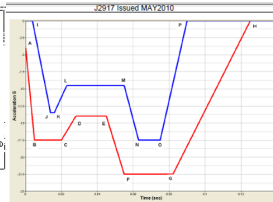
Unlike typical passenger vehicles, in a crash a modular ambulance exhibits primary and secondary impacts creating the "double hump" pulse as seen in J2917

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Building New Ambulance Test Methods: Must be relevant to ambulance crash characteristics



FMVSS 213
Pulse Corridor



SAE J2917
Pulse Corridor

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**Building New Ambulance Test Methods:
Must be relevant to ambulance crash characteristics**



Unlike typical passenger vehicles, in a crash a modular ambulance exhibits primary and secondary impacts creating the "double hump" pulse as seen in J2917

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**Recommended Practices: NIOSH & Ambulance
Builders Working Together**

- Government & Industry Partners
 - MGA Research
 - Ambulance Manufacturers Division of NTEA
 - NHTSA: Vehicle Research & Testing Center
 - General Services Administration



Using energy derived from full vehicle crash testing, the team was able to design and test new crashworthy components for use in the ambulance

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**Society of Automotive Engineers Intl. (SAE)
Recommended Practices**

- SAE J2917 Frontal Crash Pulse
- SAE J2956 Side Crash Pulse
- SAE J3044 Rear Side Crash Pulse
- SAE J3027 Patient Cot Test Methods
- SAE J3026 Seating Test Methods
- SAE J3043 Equipment Mounts
- SAE J3102 Under Strength Test
- SAE J3059 Head Excursion for Seated Occupant
- SAE J3057 Modular Body Strength Test
- SAE J3058 Cabinet Content Retention Test

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SAE J3027 Litter Integrity, Retention & Restraint

Revised from J3027 Recommended Practice (SAE 2014-01-0292) to J3027 (SAE 2014-01-0323)

SAE	SURFACE VEHICLE RECOMMENDED PRACTICE	J3027	JUL2014
INTERNATIONAL	Ambulance Litter Integrity, Retention, and Patient Restraint	Issued	2014-01

RATIONALE:
The SAE Recommended Practice was developed by members of the SAE Truck Cabwork/Seater Committee in support of the ambulance industry's need to apply science to the design and testing of the patient litter, its attachment hardware to the vehicle, and the restraint system for the patient. The Recommended Practice was developed collaboratively by industry and government entities through extensive testing funded and managed by the National Institute for Occupational Safety and Health, the National Institute of Standards and Technology, and the National Highway Traffic Safety Administration. The testing for the dynamic testing was performed using the vehicle specific crash pulses described in SAE J2537 and SAE J2592, respectively. An independent analysis of the testing methodology and resulting data was performed by government and private members of the automotive testing community.

Key Elements:

- *Dynamic, crash testing is required using front, side and soon rear impact crash pulses**
- *Litter, litter mounting and restraints structurally sound**
- *Occupant excursion reduced to less than 14 inches**

1. SCOPE
This SAE Recommended Practice describes the testing procedures required to evaluate the integrity of a ground ambulance level patient litter, their retention system, and patient restraint when exposed to a frontal or side impact. Its purpose is to provide their manufacturers, ambulance facilities, and operators with testing procedures and, where applicable, acceptance criteria that, to a great extent, ensure the patient litter, litter retention system, and patient restraint system performs in accordance with the performance goals outlined in the test which is applied to other vehicle seating and restraint system systems. Description of the test setup, test instrumentation, photograph/video coverage, test layout, and performance metrics are included.

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 Publications
Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001; Tel: 677-6767/7330 (inside USA) and Canada; 1-724-776-4870 (outside USA); www.sae.org

SAE J2513 - Instrumentation for Impact Test - Part 1: Electronic Instrumentation
SAE J2512 - Instrumentation for Impact Test - Part 2: Photographic Instrumentation
SAE J2592/ISO 22764-33 - "Strong Motion Shaker" SOT-Photographic Instrumentation System

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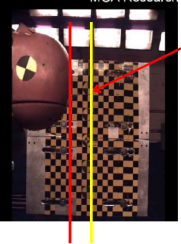
Production Cot – Successfully Meets Proposed Recommend Practice Criteria

Center Text



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SAE J3027: Patient Litter & Restraint (14 inch Excursion Limit – The Goal Line View)



Max
Excursion
Limit = 14"

Production litter, litter restraint, and occupant restraint – max excursion 11"
This test meets the new standard

** Manufacture not identified due to confidentiality agreement

What is the impact when adopting new crashworthy cot requirement?

- The existing antler system will not meet the new standard
- Future ambulances will need to be outfitted with new, crashworthy floor fixtures or cot mounts
- Very few existing cots will work in the new mounts (please see each manufacturer for specific details)
- New, complete cot and floor retention systems range from about \$7,000 to \$40,000
- You do not have to purchase a high end powered cot: Ferno already offers a manual load cot and Stryker has one in development

SAE J3026: Seat and Occupant Restraint

SAE International	SURFACE VEHICLE RECOMMENDED PRACTICE	SAE J3026 (Rev. 08-2009)
		Revision: Proposed Draft
		Copyright: SAE Int'l Std. Council/SAE
		Supersedes: J3026-00

Ambulance Patient Compartment Seating Integrity and Occupant Restraint

SAE J3026-02

The SAE Recommended Practice was developed by a committee of SAE Truck and Bus members. Committee members are responsible for the technical content of the Recommended Practice. The SAE Recommended Practice does not constitute a contract. It is the property of SAE International. It is not to be used for advertising or promotional purposes, for creating new standards, or for resale.

1. SCOPE
This SAE Recommended Practice describes a seating system required to evaluate the integrity of ground ambulance patient compartment seating and occupant restraint systems for vehicle accidents involving the patient compartment. It is applicable to ambulances with a gross vehicle weight rating (GVWR) of 10,000 lb (4,536 kg) or less. It does not apply to ambulances with a GVWR greater than 10,000 lb (4,536 kg) or to ambulances with a GVWR of 10,000 lb (4,536 kg) or less that are used for purposes other than patient transport. It does not apply to ambulances with a GVWR of 10,000 lb (4,536 kg) or less that are used for purposes other than patient transport. It does not apply to ambulances with a GVWR of 10,000 lb (4,536 kg) or less that are used for purposes other than patient transport.

2. APPLICABILITY
This Recommended Practice is a part of the qualifications for the vehicle specified herein. Unless otherwise indicated, the references to SAE standards are in effect.

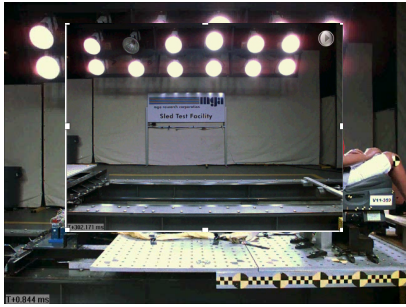
3.1. Applicable Publications

- SAE J2211-1 Instrumentation for Impact Test—Part 1: Electronic Instrumentation
- SAE J2211-2 Instrumentation for Impact Test—Part 2: Photographic Instrumentation
- SAE J2211-3 Instrumentation for Impact Test—Part 3: Photographic Instrumentation
- SAE J2211-4 Instrumentation for Impact Test—Part 4: Photographic Instrumentation
- SAE J2211-5 Instrumentation for Impact Test—Part 5: Photographic Instrumentation
- SAE J2211-6 Instrumentation for Impact Test—Part 6: Photographic Instrumentation
- SAE J2211-7 Instrumentation for Impact Test—Part 7: Photographic Instrumentation
- SAE J2211-8 Instrumentation for Impact Test—Part 8: Photographic Instrumentation
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- SAE J2211-12 Instrumentation for Impact Test—Part 12: Photographic Instrumentation
- SAE J2211-13 Instrumentation for Impact Test—Part 13: Photographic Instrumentation
- SAE J2211-14 Instrumentation for Impact Test—Part 14: Photographic Instrumentation
- SAE J2211-15 Instrumentation for Impact Test—Part 15: Photographic Instrumentation
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- SAE J2211-100 Instrumentation for Impact Test—Part 100: Photographic Instrumentation

Key Elements in Recommended Practice

- Dynamic, crash testing is required in each lockable seat position
- Bench seats are included
- Seat and restraint systems must protect occupants to same injury criteria as automotive seating
- Utilizes H111 and ES2-re 50th male ATD as appropriate.

J2917 Frontal Impact, Forward and Rear Facing Seating



SAE J3043 - Equipment Mounting: Static and Dynamic Test Options

	SURFACE VEHICLE RECOMMENDED PRACTICE	SAE J3043 Proposed August 1 st , 2013 Issued Date (2013) Draft Revised Proposed Draft Cancelled Cancelled Superseding Access Date Superseded By
	Ambulance Equipment Mount Device or Systems	
	<small>RATIONALE</small>	
	<p>The SAE Recommended Practice was developed by members of the SAE Truck, Coach/Commercial, Committee in support of the ambulance industry. It is intended to apply to the design and testing of the equipment mount devices or systems used in the ambulance patient compartment. The Recommended Practice was updated and endorsed by industry and government partners through extensive testing funded by the National Institute for Occupational Safety and Health and the Department of Homeland Security. Input for testing for dynamic loading was generated using the vehicle specific crash pulse described in SAE J2011 and SAE J2016, respectively. An independent analysis of the testing methodology and resulting data was performed by government and private members of the automotive testing community that did not have a stake in the effort.</p>	
	<p>1. SCOPE The SAE Recommended Practice describes the dynamic and static testing procedures required to evaluate the integrity of equipment mount device or system when subjected to loads in a crash impact. It proposes to provide equipment manufacturers, ambulance builders, and end-users with testing procedures and other appropriate acceptance criteria that, for a given event, ensure equipment mount devices or systems meet the same performance criteria across the industry. Proposed equipment mount manufacturers or end-users may also consider performance criteria during testing or static loading. Descriptions of the test setup, test instrumentation, photographic/video coverage, test fixtures and performance metrics are included.</p>	
<p>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.</p> <p>2.1 Applicable Publications Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-839-7323 (inside USA and Canada) or 724-776-4873 (outside USA) (www.sae.org)</p> <p>SAE J2011-1 Instrumentation for Impact Tests—Part 1: Electronic Instrumentation</p>		

Key Elements In Recommended Practice

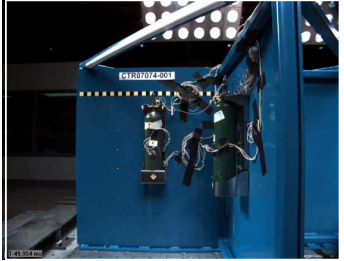
- **Dynamic testing utilizing pulses is an option**
- **Static test in lieu of dynamic test is also an option**
- **Innovative conversion from dynamic to static test loading offered**

Equipment Mount Test Standard: Dynamic Test Option

Equipment Mount Dynamic Test Standard

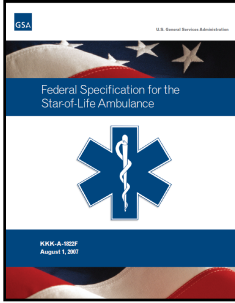
Utilizes Front and Side Impact Pulses

Orientation defined by Manufacturer



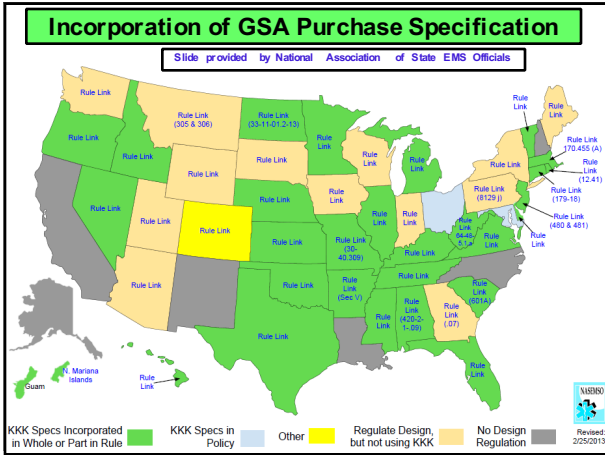
SAE Recommended Practices

GSA Purchase Specification KKK-A-1822F



- ▶ First published in early 1970's
- ▶ Now includes J3026 & J3027
- ▶ Used by the Federal Government to purchase 200 – 300 ambulances annually
- ▶ Referenced by approximately 30 states


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Specs and Standards Today & Tomorrow

NFPA 1917
Standard for
Ambulance
Effective 2016
2nd Edition

Chp. 6, Art. 7/1/2015

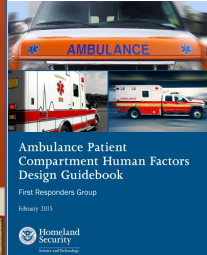




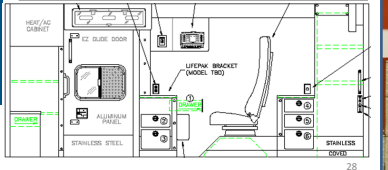
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Society of Automotive Engineers (SAE)
Test Methods:
 Crash Test Pulses, Seats, Cots,
 Equipment Mounts, Cabinets,
 Body Structure, Floor Structure

The Future: Human Factors and Safety Driven Ambulance Design



- ▶ Guide to best practices to augment a safer work and patient care environment
- ▶ Result of more than 4 years of r&d, testing, modeling & simulation
- ▶ Promotes “task based” ambulance interior design
- ▶ Ideally, the Interior will be designed around a “primary care position” where all vital tasks can be accomplished while safely restrained.



Pediatric Considerations

NHTSA Working Group Best-Practice Recommendations for the Safe Transportation of Children in Emergency Ground Ambulances (pub. 2012)

- Working group of members from Children’s Health, Medical and Emergency Organizations as well as Federal agencies was developed
- Review of the literature of current practices for the transportation of children in ground ambulances was completed
- 5 topics were addressed following the review including: Background, ambulance safety issues, existing guidelines, current practices and outcomes and safety research

Pediatric Considerations

- Pediatric patients in ambulances are not children in “standard” passenger vehicles
- In many cases, child seats & restraints designed for “standard” passenger vehicles may not be used safely in the ambulance in the way that they were designed and tested
- In some cases child seats and restraints marketed specifically to the EMS market may not be crash tested or crash tested to passenger vehicle standards not directly applicable to their use in an ambulance



Pediatric Considerations

Goals

- All ambulances should have seats and restraints capable of safely securing children from newborn up to when they may be safely secured in the adult restraints
- All Child seats/restraints in ambulances should be tested to FMVSS 213 standards for ATDs and injury criteria using the pulse criteria from J3026
- Child seats/restraints should only be attached to ambulance seats that have been tested and comply with standards of J3026
- Child seats/restraints should only be attached to cots, cot mounts and restraints that have been tested and comply with standards of J3027
- Child seats/restraints would never be attached to a side facing seat or bench
- Infants should NEVER be held in a passenger or attendant's arms

Thank You!



Questions?
