Collaborative Development of Ambulance Crash Safety Standards: A Progress Report

Presented by: Jim Green, NIOSH, Safety Engineer
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Presentation Overview

• Background & Participants

• Review Crash Test Standard Development
  – Crash Pulses
  – Seating and Restraints
  – Patient Cot and Restraint
  – Equipment Mounts
  – Body Integrity

• Incorporation of Standards – The Future?
  – GSA KKK-A-1822
  – NFPA 1917
Background & Participants

Bringing the right expertise to address the problems to be solved: Improving Occupant Safety
Overarching Goals of this Research Partnership (NIOSH and AMD)

- Provide patient compartment occupants with the same level of crash protection as passenger vehicles
- Work with end users to ensure designs meet needs
- Near Term: Develop system specific standards for publication to be referenced nationally or internationally
- Long Term: Incorporate changes into one or more bumper-to-bumper ambulance national standards

*** Most Importantly - Ensure all proposed standards are based on actual test data ***
Automotive Testing Expertise Applied

• Testing performed by three private companies at five different crash test facilities from Wisconsin to Virginia
  – Center for Advanced Product Evaluation (CAPE)
  – MGA Research
  – Transportation Research Center

• Government research support
  – National Highway Traffic Safety Administration’s
    • Vehicle Research Test Center, East Liberty, Ohio
    • Office of Vehicle Crashworthiness Research, Washington, DC
  – Federal Aviation Administration’s
    • Crash Dynamics, FAA Aviation Safety
    • Civil Aerospace Medical Institute
Auto Testing Principals & Tools Utilized

- Anthropometric Test Devices (crash test dummies)
  - Hybrid III for frontal impact testing
  - ES2-re for side impact testing
  - Utilized the same human injury tolerances values as required in Federal Motor Vehicle Safety Standards (FMVSS)

- NHTSA FMVSS Frontal Crash Impact Velocities

- Insurance Institute for Highway Safety (IIHS) Side Impact Crashworthiness Evaluation Crash Test Protocol

- IIHS Moving Deformable Barrier – Side and Rear Impacts
Crash Standard Development

Vehicle Response Provides Foundation for Future Work
Understanding Vehicle Crash Response

Vehicle Response in Full Scale Crash Testing

Frontal Impact
SAE J2917
May 2010

Side Impact
SAE J2956
Jun 2011

Rollover Test
Feb/Sept 2013

Rear Impact
Feb 2013

Side Shear
June 2013

CDC

NIOSH
Frontal Impact – 3 Conducted Matches Federal Standard
Side Impact – 4 Conducted Matches IIHS Side Impact Test
SAE J2917 - Ambulance Patient Compartment Frontal HYGE Sled Pulse, May 2010

SAE J2956 - Ambulance Patient Compartment Lateral HYGE Sled Pulse, June 2011
Both tests utilized the IIHS moving deformable barrier

- MDB weight was 1,500 kg or 3,300 lbs.
- Impact velocity 50 kph or 31 mph
- Vehicle instrumentation package described in SAE 2007-01-4267
- E350 Type II weighed 8,840 lbs. while the E350 Type III weighed 9,975
Testing Criteria – Rear Impact

Crash response of two vehicles used to develop new SAE Recommended Practice for Rear Impact Testing

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SURFACE VEHICLE RECOMMENDED PRACTICE

Occupant Restraint and Equipment Mounting Integrity – Rear Impact System-Level Ambulance Patient Compartment

RATIONAL

Not Applicable

1. Scope—This SAE Recommended Practice describes the test procedures for conducting frontal impact occupant restraint and equipment mounting integrity tests for ambulance patient compartment applications. Its purpose is to describe crash pulse characteristic and establish recommended test procedures that will standardize restraint system and equipment mounting testing for ambulances. Descriptions of the test setup, test instrumentation, photographs/videos, and the test fixtures are included.

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15086-0001.

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

2.2 Other Publications


Code of Federal Regulations, Title 49, Part 572


NIOSH Report CTR07376 - Type III Ambulance Rear Impact, NTIS Accession Number PB20130000
Body Integrity and Mounting Standards

- Front corner of patient compartment absorbed impact
- Side was sheared off
- Very different from pure side impact

Goal is to understand side shear and vehicle rollover loading on body
We need to understand the loading applied to the ambulance body at impact

≈ 30 mph – likely survivable

≈ 60 mph – likely not survivable

Ramp Roll Test – 30 MPH/48 KPH
Barrier Impact Test – 30 MPH/48 KPH
Body Integrity and Mounting Standards Development Team

Progress to date: 60% Complete

• Can we devise a test to ensure patient compartment structural integrity – especially during side shearing events or under rollover conditions?

• Conducted two rollover tests and two shear tests

• Results from the four tests will be used to create and execute repeatable quasi-static test (the committee met this morning to start this final process)

• This test will be translated to SAE document Spring 2014
Standards Development Activities

Vehicle Crash Response: Results Drive Change

- Seating & Worker Restraints SAE J3026 Pending
- Litter & Patient Restraints SAE J3027 Pending
- Interior Delethalization
- Equipment Mounting SAE 3043 Pending
- Patient Compartment Integrity
Seat and Worker Restraint Standard

Key Elements in Recommended Practice

- Dynamic, crash testing is required
- Seat and restraint systems must protect occupants to same crash standard as automotive seating
- Occupant excursion mapped during dynamic test
Demo: Frontal Impact, Forward and Rear Facing Seating
Mapping Occupant Excursion

**FIGURE C.** (Forward facing seat)

- Excursion Zone
- Head Path
- Maximum Travel Distance
- Foremost Seat Plane
- *POINT 1

*All specified positions are closest toward the direction of impact*

**FIGURE D.** (Side facing seat)

- Excursion Zone
- Head Path
- Maximum Travel Distance
- Foremost Seat Plane
- *Point 1

*Seat adjusted to foremost position relative to the front of the seat*
Litter Design – Patient Restraint Team

Key Elements in Recommended Practice

- Dynamic, crash testing is required
- Cot, cot mounting and restraints structurally sound during simulated crash loading
- Occupant excursion reduced to less than 14 inches
Standard Gurney – 30 mph Impact

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

Mid-crash event: patient excursion exceeds 30 inches or 76 cm
Rigid Cot and with new Restraint Tested Using J2917 (30 mph)

Pre-crash event:
rigid cot, new restraint applied directly to shoulder

Mid-crash event:
total head excursion of 7.8 in / 20 cm
Equipment Mounting: Static and Dynamic Test Options

Key Elements in Recommended Practice

- Dynamic testing based on published pulses is an option
- Optional static test in lieu of dynamic test is an option
- Innovative conversion from dynamic to static test loading offered
Equipment Mount Integrity

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

Post crash (rollover) equipment and gurney positions drastically changed.
Additional Work Underway

• Interior Surface Delethalization – making impact surfaces less likely to injure the worker or patient

• Cabinet and cabinet latch integrity standard – will ensure cabinets retain equipment using established crash pulses

• EMS Worker Anthropometry Study – Assessing body sizes and shapes (600 human subjects to be measured)

• Development of a prototype ambulance based on this work plus companion research at the National Institute of Standards and Technology (NIST) dealing with patient compartment layout

• Production of an informational DVD to be provided to all EMS services nationwide
Incorporation of Crash Safety Standards

What is the Future?
GSA KKK-A-1822 ?
NFPA 1917 ?
Existing AMD standards will continue to be referenced in KKK.

New SAE Standards will be added to KKK as published beginning in FY2014.
Suggestions for NASEMSO Members

• Participate in the NFPA 1917 process – the committee needs to understand and appreciate your state’s needs and potential limitations

• Know the purchasing and licensing requirements that exist within your state today
  
  • How will they need to evolve in this changing environment?

• Understand the limits of the science today, but more importantly work to separate fact from fiction
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