What’s Changing in Ambulance Standards?
Partnering with Industry to Build Safe EMS Work Environments

Jim Green (NIOSH)
Overarching Goals of this Research

• Provide patient compartment occupants with the same level of crash protection as is found in passenger vehicles

• Work with end users to ensure designs meet their needs

• Partner with manufacturers to ensure adoption of consensus standards in the absence of a regulatory requirement to do so

• Near Term: Develop 10 system specific test methods for publication to be referenced nationally or internationally - Completed

• Long Term: Incorporate new test methods into one or more bumper-to-bumper ambulance national standards - Ongoing
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.
An external view of the full vehicle crash testing performed
Structural Concerns with Existing Litter Retention Devices & Seating Systems
Production Cot – Successfully Meets SAE J3027 Recommend Practice Criteria
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
• This test also provided positive test results for SAE J3027 – patient cot for structural integrity and excursion.

• Met floor strength requirements in SAE J3102
Equipment Mount & Cabinet Integrity: Flying Equipment and Supplies are a Hazard

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

Post crash (rollover) equipment and gurney positions drastically changed
SAE J3026 requires all seating to be tested in the orientation in which it is installed using a 171 lb. crash test dummy.
Head path comparison 2 pt lap belt versus 6 pt restraint

2 point restraint

6 point restraint

Upper torso restraints enhance occupant safety!
Cabinets will be tested to a weight rating identified by the builder. Labeling will likely be required.
Impact loading of 28,000 ft-lb – twice the requirement for the cab of large trucks

After roof edge impact, phase 2 of the test requires a vertical roof crush test

All doors must open after test completed

Intended to simulate side roll with roof line impacting ground
SAE Documents

SAE J2917
SAE J2956
SAE J3044
SAE J3056
SAE J3057
SAE J3058
SAE J3059
SAE J3071
SAE J3027
SAE J3043
SAE J3102
SAE J3044
SAE J2917
How do SAE tests impact ambulances built to new test methods and standards?

- SAE J3026 requires all seating to be crash tested with a crash test dummy. This includes the bench seat.
- SAE J3027 requires the cot and floor fixture be crash tested. This requirement effectively eliminates the antler style cot mounting system and cot from future use.
- SAE J3043 requires equipment mounts to be tested.
- SAE J3058 requires all cabinets to be tested to a rated loading.
- SAE J3057 requires a new dynamic roof crush test be performed.
- SAE J3102 requires a test of the floor structure under the cot.
New Test Methods Published by the Society of Automotive Engineers

Last of 10 SAE Test Methods published in April 2017!

All available through SAE’s website
Test Methods Referenced by National Standards

- 2016 Edition
  References first 6 SAE Test Methods

- 2017 Change
  Notice in draft references all 10 SAE Test Methods

- 2016 Edition
  References first 6 SAE Test Methods

- 2019 Edition in draft references all 10 SAE Test Methods

- 2016 Edition
  References first 6 SAE Test Methods

- Awaiting information from CAAS regarding 2nd Edition
Using energy derived from full vehicle crash testing, the team was able to design and test new crashworthy components for use in the ambulance.
NIOSH partnered with Department of Homeland Security’s Science and Technology Directorate as well as other federal agencies and the ambulance industry to develop a 7-part video series that covers new crash test methods.

Video series became available on the NIOSH EMS Workers webpage the week of May 22, 2017

www.cdc.gov/niosh/topics/ems/videos.htm
Contact Information

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“The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health (NIOSH). Mention of company names or products does not imply endorsement by NIOSH.”
Ambulance Patient Compartment Human Factors Design Guidebook
First Responders Group
February 2015
Homeland Security
Science and Technology
Design Assumptions

• Designs are based on requirements and criteria
• Design is not “standard” and only serves the purpose of visualizing optional layouts
• One patient on cot
• Curbside & roadside seats on track
• Cables, tubing, & leads are routed along wall/ceiling
• Design does not necessarily address crashworthiness
• CPR/intubation cannot be performed while seated
• IV bag will be hung prior to transit
• Curbside workstation is the primary medic seat
• Jump bags are the primary storage for immediate care items
Key Human Performance Requirements

• Use the human performance requirements to drive the design.

• The EMS provider shall be able to reach the patient’s body from head to knee while in a seated and restrained position.

• The EMS provider shall be able to reach common and critical equipment/supplies from a seated and restrained position.

• The EMS provider is able to face and interact with the patient while in a seated and restrained position.
Conceptual Design – Helps to Validate Design Requirements
Roadside Seat
Curbside Seat
Modeling with Mannequins
Guidebook

• Ambulance Design Guidebook covers best practices, recommendations, and ergonomics.
  – Final, pending release by DHS
  – Intended to be a practitioner guide and not a standard
  – Covers user-defined process, steps to take to develop design requirements and basic systems engineering
  – Also addresses some best practices or recommendations in the following areas:
    • Equipment layout and workflow
    • Lighting, noise, HVAC
    • Storage
    • Ingress/egress (patient and EMS worker)
    • Labeling
    • Communications and information technology
    • Restraints and seating
    • Surfaces and materials (incl. decontamination)
Standards vs Standards

- **Testing Standards** for Specific Safety Criteria
  a. AMD
  b. NIOSH = SAE

- **Bumper to Bumper Vehicle Standards**
  a. KKK-A-1822F
  b. CAAS GVS v.1.0
  c. NFPA 1917
<table>
<thead>
<tr>
<th>Requirement</th>
<th>KKK-A-1422F</th>
<th>NFPA 1917, 2016</th>
<th>CAAS-GVS v1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMD testing to verify compliance</td>
<td>AMD Tests 1, 4, 6, 8, 10, 12, 15, 16, 18, 21, 24, 25, 27 required</td>
<td>AMD Tests 1, 4, 6, 8, 10, 12, 15, 16, 18, 21, 24, 25, 27 required</td>
<td>AMD Tests 1, 4, 6, 8, 10, 26 required</td>
</tr>
<tr>
<td>Payload requirement</td>
<td>Type I: 1,300 pounds maximum, Type II: 1,750 pounds maximum, Type III: 2,250 pounds maximum</td>
<td>Type I: 1,300 pounds minimum, payload after all options</td>
<td>All Types: 1,300 pounds minimum, payload after all options</td>
</tr>
<tr>
<td>Vehicle type certification</td>
<td>Proof of compliance and complete certification testing by ISO-approved laboratory is required for each type</td>
<td>Third party testing required for some parts of standard</td>
<td>Proof of compliance and complete certification testing by ISO-approved laboratory is required for each type</td>
</tr>
<tr>
<td>Occupant payload calculations</td>
<td>Weight calculated at 177 lbs/person</td>
<td>Weight calculated at 171 lbs/person</td>
<td>Weight calculated at 171 lbs/person</td>
</tr>
<tr>
<td>Vehicle cold start</td>
<td>AMD 023 or chassis manufacturer certification</td>
<td>Requires own test</td>
<td>AMD 023 or chassis manufacturer certification</td>
</tr>
<tr>
<td>Engine horsepower</td>
<td>Optional</td>
<td>Required</td>
<td>Optional</td>
</tr>
<tr>
<td>Suspension clearance angles</td>
<td>Approach: 10 degrees; Departure: 10 degrees</td>
<td>Approach: 10 degrees; Departure: 10 degrees</td>
<td>Approach: 20 degrees; Departure: 20 degrees</td>
</tr>
<tr>
<td>Tire pressure monitor</td>
<td>Optional</td>
<td>Visual indicator or monitor required</td>
<td>Optional</td>
</tr>
<tr>
<td>CD monitor</td>
<td>Testing per AMD 007 required</td>
<td>Monitor required</td>
<td>Testing per AMD 007 required</td>
</tr>
<tr>
<td>Bulkhead/Partition</td>
<td>Bulkhead with latchable door (Type III only)</td>
<td>Bulkhead with window</td>
<td>Bulkhead with window required and sliding door optional (Type III only)</td>
</tr>
<tr>
<td>Floor loading height</td>
<td>Maximum is 34&quot;</td>
<td>Maximum suggested load height 34&quot;</td>
<td>Maximum is 34&quot;</td>
</tr>
<tr>
<td>Access handholds</td>
<td>Grab handle on inside of each door and adjacent body structure</td>
<td>Interior or exterior grab handle on cab-end and patient compartment at each step location</td>
<td>Grab handle on inside of each door and recessed overhead grab rail required</td>
</tr>
<tr>
<td>Required door openings</td>
<td>Two doors required; minimum dimensions provided</td>
<td>Two doors required; minimum size 30&quot; x 48&quot;</td>
<td>Rear and side doors required; minimum dimensions provided</td>
</tr>
<tr>
<td>Floor testing requirements</td>
<td>AMD 20 floor deflection test required to prove floor load capacity</td>
<td>ASTM 6610 compliance required</td>
<td>AMD 20 floor deflection test required to prove floor load capacity</td>
</tr>
<tr>
<td>Equipment storage criteria</td>
<td>Minimum 35 cubic feet of interior storage; all devices to be fastened to manufacturer recommendations</td>
<td>All equipment 3 lbs or more to be mounted or stored in enclosure or bracket</td>
<td>Purchaser to specify storage requirements</td>
</tr>
<tr>
<td>Cabinet storage load</td>
<td>Each cabinet to be labeled with mass load</td>
<td>Not specified; per equipment manufacturer's recommendation</td>
<td>Oxygen mounts and fire extinguisher shall meet SAE J1043</td>
</tr>
<tr>
<td>Communication devices</td>
<td>Optional</td>
<td>Communication devices installed in patient compartment shall be within reach of EMS personnel without repositioning or retraction</td>
<td>No requirement</td>
</tr>
<tr>
<td>Seat belt requirements</td>
<td>Seat belts must meet all FMVSS, AMD, and SAE J2266 requirements</td>
<td>Meet all required FMVSS and require special length type I seat belts for vehicles with a GVWR of 11,000 or more</td>
<td>Seat belts must meet all FMVSS requirements</td>
</tr>
<tr>
<td>Access to patient</td>
<td>Primary attendant seat min 25&quot; from head of cot</td>
<td>Seat to cot dimension permitted to allow multiple cot positions</td>
<td>Primary attendant seat min 25&quot; from head of cot</td>
</tr>
<tr>
<td>Seat belt warning</td>
<td>&quot;Fasten Seat Belt&quot; label required</td>
<td>Seat belt monitoring system required with visual and audible alert in cab and/or compartment</td>
<td>&quot;Fasten Seat Belt&quot; label required</td>
</tr>
<tr>
<td>Main electrical printed circuit board</td>
<td>Certified to &quot;Class 3 life support&quot; standard</td>
<td>Non-life-support systems certified to Class 2 commercial/industrial area. Lift-saving systems certified to Class 3 life support standard</td>
<td>Certified to &quot;Class 3 life support&quot; standard</td>
</tr>
<tr>
<td>Wire harness protective loom</td>
<td>300 degree F maximum rated</td>
<td>194 degree F minimum continuous-rated</td>
<td>300-degree F maximum rated</td>
</tr>
<tr>
<td>Warning lights</td>
<td>KKK, SAE or NFPA configuration acceptable</td>
<td>NFPA zone lighting or KKK acceptable</td>
<td>Purchaser to specify</td>
</tr>
<tr>
<td>Ground lighting under vehicle</td>
<td>Stop lights to be illuminated</td>
<td>Under-body lighting required at step/access points</td>
<td>Step lights to be illuminated</td>
</tr>
<tr>
<td>Exterior compartment lighting</td>
<td>Requires exterior compartments to be illuminated</td>
<td>Each exterior compartment greater than 4 ft or opening greater than 144 sq. ft. shall have minimum of 1.5% at all locations</td>
<td>Requires exterior compartments to be illuminated</td>
</tr>
<tr>
<td>Warning indicators</td>
<td>&quot;DO NOT ENTER&quot; light</td>
<td>&quot;DO NOT ENTER&quot; light attached to open door, equipment rack not lowered, or attached device open or displayed</td>
<td>&quot;DO NOT ENTER&quot; light</td>
</tr>
<tr>
<td>Warning lights requires</td>
<td>Detailed requirements for generators under 11 hp</td>
<td>Not specified</td>
<td>Not specified</td>
</tr>
<tr>
<td>Reflective striping</td>
<td>6&quot;-14&quot; orange reflective strip around body or equivalent</td>
<td>Min 6&quot; reflective strip or combination design on 25% length of cab and 75% length of body</td>
<td>Purchaser to specify</td>
</tr>
<tr>
<td>Crew windows</td>
<td>Optional</td>
<td>50% of view (including glass) reflective with any design; chrome optional</td>
<td>Purchaser to specify</td>
</tr>
</tbody>
</table>

DISCLAIMER: This document is not a comprehensive comparison and has not been independently verified. Regulatory and purchasing decisions should be made solely upon a comprehensive review of the contents of these documents and the rules of the state in which the ambulance is intended to be licensed. Questions should be directed to the standards document caretaker and your state EMS office. For more information please see www.SafetyAmbulances.org. April 14, 2016.
Ground Vehicle Standard for Ambulances

v.1.0 Edition

Established and Maintained by CAAS
The Commission on Accreditation of Ambulance Services

www.caas.org
Who is CAAS?

Commission on Accreditation of Ambulance Services - Accreditation Standards:

- Standards for enhancing quality and performance for licensed ambulance service providers
- Established in 1990
- “Gold Standard” - exceeds state EMS licensure requirements
- Voluntary, or as required by state/county or local ordinance
- When met - the ambulance service/organization is granted accreditation
- www.caas.org
CAAS Involvement

The Commission on Accreditation of Ambulance Services (CAAS) was asked by several National Organizations to develop an Ambulance Standard to replace the KKK specification.

CAAS represents the complete EMS spectrum, not just one specific sector of EMS.

The CAAS Board of Directors representation is multifaceted, representing the broad industry.
CAAS GVS

GVS Ground Vehicle Standard v.1.0:

• Standard for the design of new ambulances
• Establishes minimum standards, performance parameters and essential criteria for the design of ambulances
• Provides a practical degree of standardization
• Effective July 2016
• When built to the GVS standard- the vehicle will bear the GVS logo
• Does not require or imply CAAS accreditation which is a separate program
• www.groundvehiclestandard.org
Specification

• GVS foundation is KKK
• Applicable to new production vehicles only
• Accommodates current chassis offerings
• Maintains certain important quality criteria
• Includes new NIOSH/SAE Safety Standards
• Allows purchaser flexibility with consideration for local requirements
It does include

• Purchaser ability to define emergency lighting configuration
• Purchaser ability to define exterior graphics design and colors
• Continuity of KKK enhanced electrical system requirements- “Class 3 Life Support”
• Continuity of KKK enhanced floor structure and loading requirement (AMD 20)
• New defined minimum payload requirement of 1,300 pounds for every vehicle *including options*
It does include

• Ability for purchaser to deviate from standard as allowed by state, exceptions to be defined by FSAM
• Additional enhancements are suggested, not required
• Required compliance for all AMD testing standards #01-25.
• FSAM required to provide Type Testing and Certification for each ambulance model from certified independent testing facility.
GVS V1.0 includes new SAE safety requirements that are researched by NIOSH:

- SAE J3026  Patient Compartment Seating
- SAE J3027  Litter Fasteners and Anchorage
- SAE J3043  Ambulance Equipment Mounting and Retention

To be included in V1.1 in 2017:

- SAE J3057  Modular Body Integrity
- SAE J3058  Cabinet Testing
- SAE J3059  Occupant Excursion
- SAE J3102  Litter Sub Floor Test
RETHINKING REMOUNTS

Developing a national standard for ambulance remounts

By Lorie Aguilera

The California Association of Fire Angels (CAAS), for many years established a National Vehicle Standards (NVV) for fire and EMS. The NVV standard has been highly accepted by the states (California, Nevada, and Utah), and regulatory approval is pending in many states.

As part of its development plan for a project, the California Association of Fire Angels partnered with the Congenital Remounts Standard (CRS) in 2019, to develop a new remount standard. The project is currently sponsored by the California Association of Fire Angels (CAAS) and the National Association of State EMS Directors (NASEMSD).

The project is led by the California Association of Fire Angels (CAAS) and the National Association of State EMS Directors (NASEMSD). The project is currently sponsored by the California Association of Fire Angels (CAAS) and the National Association of State EMS Directors (NASEMSD).

The ambulance remount business is complex, with numerous moving parts.

CREDENTIALS, PROCESS & PRODUCT

The California Association of Fire Angels (CAAS) has developed a new remount standard, which is currently sponsored by the California Association of Fire Angels (CAAS) and the National Association of State EMS Directors (NASEMSD). The project is led by the California Association of Fire Angels (CAAS) and the National Association of State EMS Directors (NASEMSD).

The ambulance remount business is complex, with numerous moving parts.

FEDERAL STANDARDS & PERSPECTIVES

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The ambulance remount business is complex, with numerous moving parts.

In conclusion, the California Association of Fire Angels (CAAS) has developed a new remount standard, which is currently sponsored by the California Association of Fire Angels (CAAS) and the National Association of State EMS Directors (NASEMSD). The project is led by the California Association of Fire Angels (CAAS) and the National Association of State EMS Directors (NASEMSD).

The ambulance remount business is complex, with numerous moving parts.
Remounts

• Remounting of ambulances has grown exponentially in last 5-10 years
• Estimated to be 3 times more Remounters than new ambulance manufacturers
• Estimated number of remounts is equal to 25% of total new ambulance production
• No regulations for Remounters or remounted ambulances
Remounts

- Remounted ambulances are currently exempt from KKK, GVS and NFPA standards
- ALL FEDERAL MOTOR VEHICLE SAFETY STANDARDS (FMVSS) THAT ARE APPLICABLE TO NEW PRODUCTION AMBULANCES ALSO APPLY TO REMOUNTS
- NHTSA and FMVSS require Remounters to comply with same standards as new vehicle manufacturers
- A remounted ambulance is considered a new vehicle
The KKK certification of the original vehicle is not transferable once the VIN of the chassis has changed, and the sticker is no longer valid.

• How do you relate KKK/AMD/GVS type testing certification requirements to an individual used ambulance?
Challenges of a Remount Standard

Some of the FMVSS requirements do apply to the patient compartment and are model year related.

- **FMVSS standards for door hardware/retention and seats/seat bases in the patient compartment** do change periodically, and are based on the model year of the vehicle (chassis).
Challenges of a Remount Standard

All patient compartment seat locations must meet rigorous FMVSS testing and certification requirements.

• How could a Remounteer comply with a customer request for changes in seat/seat belt configurations from the original design?
Challenges of a Remount Standard

How can a Remounter meet potential requirements for addition of some of the new SAE safety features in an older generation patient compartment?

• Some of these features could possibly be add-ons, while others likely not. Integration into an existing body could require extensive engineering, design and rework.
What type of credentials should be required of a Remounter?

- FSAMs are required to meet significant regulations, requirements and standards. They generally have significant product liability coverage, engineering resources and testing protocol.
Remount Work Group

• Will meet three times in next 9-12 months to prepare recommendations for CAAS GVS Committee to consider for remount standard inclusion in GVS V2.0.

• Meeting dates and locations will be posted on www.groundvehiclestandard.org.
CAAS GVS endorsements
Future plans for CAAS-GVS

- V1.1 to include latest SAE test methods – late 2017
- V2.0 revision July 2019
- V2.0 to include standards for Remounts
- Pediatric standards for patients and passengers to be considered as they are developed
2015 • KKK CN#8
   • Cot/mount
   • Seats

2016 • KKK CN#9
   • Eq. Restraint

2017 • KKK CN#10
   • Cabinets
   • Body
   • Floor
   • Excursion

2019 • Remounts
   • V2.0

www.safeambulances.org