Ambulance vehicle crashworthiness and passive safety design –
A comparative evaluation of USA design and testing standards

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ABSTRACT

Objectives: To evaluate crashworthiness and passive safety design and testing standards for USA and Australian ambulance vehicle design and testing.

Methods: Ambulance vehicles and safety testing requirements were identified from the USA and Australia. A comparative evaluation of the safety design and testing standards for ambulance vehicles was performed. Data sources include: testing and safety standards and specifications, vehicle specifications, government documents, photographs and crash testing conducted of ambulance vehicles. The authors have published literature on ambulance crashworthiness and crashworthiness principles.

Results: Design and safety testing requirements and standards for Australian ambulance vehicles were consistent with accepted engineering technical vehicle and occupant safety standards. However, for USA vehicles the testing standards and design requirements were not in keeping with accepted engineering technical vehicle and occupant safety standards with a number of highly misleading and potentially dangerous aspects to the standards and specifications and some practices that were well outside of anything that would be acceptable for testing and design - such as the use of static tests to demonstrate crashworthiness performance, and requirements which prevent the use of any crumple zones or impact absorbing structures. Several features identified, for the USA ambulance vehicles, demonstrated predictable serious crashworthiness and occupant protection hazards.

Conclusion: There is marked disparity in the vehicle crashworthiness and passive safety design and testing standards for ambulance vehicles in Australia and the USA - the USA ambulance design standards being outside of accepted automotive safety engineering practice. There is a need for safety researchers, emergency medical service providers and ambulance vehicle designers to recognize and apply existing crashworthiness and occupant safety design and testing standards, including dynamic impact testing procedures.

RESULTS

An ambulance vehicle is a vehicle that carries passengers - not just freight, and safety standards should address the real safety of those passengers, and accepted current automotive safety science and crash test procedures. For the AMD/KKK-F test protocols there is a complete failure to utilize any dynamic crashworthiness testing protocols and the procedures described lack meaningful or established approaches to assess injury mitigation strategies as is used routinely in automotive safety (Fig 2b). Claims that successful AMD testing as specified in the AMD standard prior to August 2007 , reduced "the possibility of injuries and fatalities ..., encountered in low or adverse forces that can result from a vehicle impact or roll over", and "minimize the possibility of failure by forces acting upon occupants "as a result of vehicle crashes and/or sudden driving maneuvers" were not supported by any technical data, injury criteria or thresholds. Such test protocols would provide misleading information that could not be supported by any current accepted automotive safety, occupant protection and crashworthiness science or any principles thereof. These statements which were in conflict with accepted, existing established technical science have now been removed from the August 2007 version of the AMD Standard. However now the current August 2007 AMD Standard makes no reference to procedures to provide any protection to the occupants of the ambulance under crash circumstances. Static test protocols do not consider any forces generated as a result of a crash impulse, e.g. inertia forces. As is uniformly known for 400 years Newton’s 2nd law of motion stating that the relative motion of an object’s mass (m), its acceleration (a), and the applied force (F) is F = ma. The static protocols also do not take into consideration occupant kinematic movement and do not in any way reflect meaningful or accepted safety tests for occupant protection. Additionally the FMVSS exemption (Fig 3a), is misleadingly addressed by the AMD position statement (Fig 3b). The lack of FMVSS applicability beyond the front cab and the failures of the AMD protocols for the safety design of the rear compartment are highlighted in Fig 4.

By contrast the Australasian ambulance safety standards refer to dynamic crashworthiness tests, use of standard crash test manikins and specific test protocols, including detailed automotive dynamic test protocols and reflect existing automotive safety science.

DISCUSSION

There is marked disparity in the vehicle crashworthiness and passive safety design standards for ambulance vehicles in Australia and the USA - the USA design and testing standards being outside of accepted automotive safety engineering practice. There is a need for safety researchers, emergency medical service providers and ambulance vehicle designers to recognize and apply existing crashworthiness and occupant safety design and testing standards, including dynamic impact testing procedures.

LIMITATIONS

This analysis was a brief analytical technical report, and does not in any way address any specific vehicle or any specific vehicle or manufacturers design, but rather addresses the broad issue of the safety of the design standards.

CONCLUSION

Ambulances in the USA are 35 times per capita more lethal than in Australia. Whilst there are many aspects that impact upon safety, this study addresses the safety design standards and guidelines for ambulances in the two countries. Ambulances in the USA are built by aftermarket ambulance manufacturers, to meet the Ambulance Manufacturers Association of America standards and the General Services Administrations KKK-F Star of Life Standard for Certification. These standards are essentially developed outside automotive safety and crashworthiness engineering oversight. Federal Motor Vehicle Safety Standard exemptions exist for the rear compartment occupants. Australian ambulances are required to meet the Australasian Standard AS/NZS 4535:1999 Ambulance Restraint Systems Standards for safety and occupant protection in ambulance vehicles. This is a national standard by an independent nationally approved standardizing agency.

For USA vehicles the testing standards and design requirements were not in keeping with accepted engineering technical vehicle and occupant safety standards with a number of highly misleading and potentially dangerous aspects to the standards and specifications and some practices that were well outside of anything that would be acceptable vehicle crashworthiness testing or design features (Fig 2a and 2b) - such as the use of static loads to demonstrate crashworthiness performance and requirements which prevent the use of any crumple zones or impact absorbing structures (Table 1). Hazards. The AMD KKK-F testing outlined was static testing only, with no acceleration (aside from gravity alone). Force = Mass x Acceleration, thus no inertial forces are described in the standard. There was no dynamic or impact crashworthiness testing required or mentioned to demonstrate safety performance of the rear occupant compartment of the ambulance at all.

REFERENCE


Fig. 1. Australasian Ambulance Safety Standard AS/NZS 4535:1999

Fig. 2a. USA KKK-F August 2007 and AMD Standards August 2007

Fig. 2b. Implementation and application of AMD ambulance safety testing procedure completely outside of accepted automotive safety testing practice