



### **D26 Rear Seat Crashworthiness: Predictable Failures of Seats, Belts, Liftgates, Vehicle Structures, and Loss of Occupant Survival Space in Rear Impacts, Especially in the Third Row**

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**Learning Overview:** This goal of this presentation is to show rear impact case studies and tests involving forensic investigation of catastrophic ejection, injuries, and fatalities due to failures of vehicle second and third row seating area structures, seats, and restraints. Parents are advised to place children in such seats to avoid airbags, but no tests are performed by automakers to determine actual occupant protection in rear impacts. No rear impact occupant protection standards exist. Flawed and inadequate seat standards allow predictable failures of structures, doors, seats, and belts in low-speed rear crashes.

**Impact on the Forensic Science Community:** This presentation will impact the forensic science community by showing how and why restrained adult and child occupants are predictably ejected, injured, and killed in low-speed rear crashes. Hidden dangers of trailer hitches, weak seat structures, slackened belts, weak liftgate, and door latches are depicted. The lack of testing by automakers or the Department Of Transportation (DOT) to evaluate rear impact occupant protection, especially in rear seats, will be explored in detail. Investigators of such collisions will be better able to evaluate injuries and forensic evidence related to rear seat occupants.

Second and third row rear seats in vehicles receive little to no attention during design, development, or testing because loopholes in United States safety regulations and automaker internal standards do not require meaningful performance evaluation of rear structures, restraints, seats, cargo shift/rear intrusion, or occupant protection. Significant improvement has occurred since 1979 in vehicle frontal and side crashworthiness due to the competitive challenges posed to automakers by the National Highway Traffic Safety Administration (NHTSA) New Car Assessment Program, including front, side, and rollover airbags; adjustable seat belt anchors; pretensioned seat belts, and improved side structures. However, there has been little-to-no corresponding improvements in rear seat crashworthiness and occupant protection. Many vehicles continue to operate with rear lap-only belts, no head restraints, weak seatback structures combined with pass-through bulkheads from rear cargo areas; seat cushions with poor anti-submarining structure, no cargo tie-downs, netting, or shields, and other significant flaws that significantly increase risks to rear seat occupants. In 1996, the DOT admitted that their seat safety standard was “flawed and inadequate.” That same year, automakers and the DOT issued warnings that children should be placed in the second or third row to avoid airbags. The DOT and automakers continue to follow the “flawed and inadequate” seat safety standard. Not surprisingly, due to these flaws, independent crash researchers discovered children are 61% more likely to incur severe or fatal trauma in rear crashes than in any other impact vector.

Case studies, testing, and simulations that illustrate these predictable dangers are analyzed in detail. As demonstrated in numerous investigations, automakers have admitted that as “normal practice,” they never measure, or even evaluate, second or third row designated seating positions in rear crash tests. For example, one automaker conducted more than 15,000 frontal sled tests and only 8 rear tests. The lack of testing, regulation, and automaker interest in rear seat occupant protection has led to significant trauma and death in readily survivable crashes. Predictable loss of rear occupant survival space due to front seat failure and belt slackening, as well as cargo shift and rear intrusion, has caused rear seat occupants to be ejected into rear vehicle structures or out of the vehicle, rammed into the roof, and inadequately restrained by belts slackened due to seatback and seat track failure.

Trailer hitch receivers have been added to rear vehicle structures without any testing to determine what effects those hitch receivers would have on rear impact crashworthiness and occupant protection. This has caused rear “crush zones” to be completely altered and rendered ineffective. This has not only decreased the energy absorption capabilities of vehicles but also translated crush far forward into the occupant compartment, causing loss of survival space. This also increased the severity of crash forces affecting vehicle occupants, with corresponding increased loads on occupants, seats, and belts.

Front and rear crash tests and static tests have been conducted and have demonstrated these predictable hazards, as well as safer alternative designs that are readily available, technically feasible, and cost effective.

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#### **Rear Impact, Rear Seat Safety, Crashworthiness**