C8 Multiple Crashworthiness Defects Affecting Vehicle Occupant Survivability in Rear Impact: Failures of Vehicle Fuel System, Seating, and Occupant Compartment Designs

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After attending this presentation, attendees will gain a better understanding of how design and safety decisions made during vehicle development will affect real-world collision outcomes.

This presentation will impact the forensic community by demonstrating how accident reconstruction, vehicle design and crashworthiness analysis, and biomechanics are combined to determine not only how fatal injuries occurred, but why they occurred to restrained occupants in a foreseeable collision.

In most collisions between large and small vehicles, the occupants of the smaller vehicle are normally at far greater risk of injury. In an unusual reversal of this, during rear impacts various safety defects can render the larger vehicle and its occupants more vulnerable than those in the smaller vehicle. This is a case study involving accident reconstruction, biomechanical analysis, and vehicle design/crashworthiness analysis to prove how and why this occurred.

A large utility vehicle containing seven restrained occupants incurred a low to moderate change in velocity after being struck in the right rear by a compact passenger car. The utility vehicle yawed and encountered a half roll as it flipped onto its roof. There was inconclusive evidence of significant roof crush because of subsequent fire damage and heat softening of the roof structures which caused the inverted vehicle to collapse toward the pavement.

The vehicle eventually was consumed by fire as a result of predictable failures of the fuel system. The vehicle had a unique aft-of- axle fuel tank located in the rear crush zone, despite the fact that virtually identical light trucks from the same manufacturer were produced with forward of axle fuel tanks. The justification for this much more hazardous location was to allow six gallons greater fuel capacity. There were significant fuel leaks caused by a failure of the filler neck-to-fuel tank junction, a distortion of the tank near the sender unit, and a hole in the tank adjacent to the greatest tank deformation and folding. Any one of these failures would have created sufficient leakage to support a significant fire. Taken in the aggregate the breaches of the fuel system created an extremely severe risk of fire. The foregoing was exacerbated by separation of the floor pan in the rear of the vehicle that allowed the leaking fuel to enter the occupant compartment. This same floor pan distortion pushed the rear seat toward the roof of the vehicle, creating significant loss of occupant survival space. The floor pan distortions were as a result of efforts to allow the fuel tank to move up and over the rear axle. The vehicle was never tested with a rear seat in place nor were any test dummies ever placed in any rear seating positions during any dynamic testing.

The driver of the passenger car and the three center rear passengers of the utility vehicle escaped without significant injury, despite the ensuing fire. The three center rear passengers were supported by the legs of the third row occupants, which prevented further collapse of the center rear seatback. However, this created entrapment of the third row seat occupants. The SUV driver and three occupants of the third row seat had no detectable crash injuries, and were conscious and talking after the crash, but died due to the fire. There were predictable failures of seats and restraint systems which affected occupant entrapment and egress from the burning vehicle. Static testing of the seats in this vehicle showed that they were the weakest among all seats tested by NHTSA at that time.

There were also predictable failures of the rear occupant compartment that reduced occupant survival space due to intrusion, and which also greatly increased the penetration of leaking fuel and fire into the vehicle interior. These combined failures were most pronounced at the third row seat area. This case illustrates the myriad of hazards of third row seats in SUV's the vast majority of which are smaller than the vehicle involved in this case. All else being equal, the occupants of other smaller SUV's and vans with third row seats placed near the rear of the vehicle are at extreme risk. Not only are there typically no dynamic tests performed with instrumented dummies in the middle and third row seats, there is no dynamic testing or evaluation of occupant protection in rear impacts or rollovers. Collapse of front and/or middle seat occupants into rear seat occupants is an additional hazard that is not addressed in typical vehicle developmental testing.

This presentation will demonstrate the forensic science involved in determining the foregoing predictable failures in a foreseeable collision involving a very common type of vehicle, and the safety implications for millions of similar vehicles under similar impact conditions. This study especially highlights the emerging safety issues of third row seating in utility vehicles. The design and testing process (and lack thereof) used to develop the vehicle clearly demonstrated the high likelihood of all these failures in foreseeable collisions, prior to initial vehicle production. Static and dynamic testing of the vehicle also demonstrated the predictability of the ensuing multiple fatalities in what should have been a readily survivable collision.

Rear Impact, Fire, Seat Failure

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