D13 A Heavy Truck Fuel-Fed Fire: Vehicle Design Failures Causing Predictable Fatality in Otherwise-Survivable Conditions

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Learning Overview: This presentation explores the case of a heavy tractor-trailer fire that killed an uninjured, restrained driver. The investigation included evaluation of the exhaust system integrity, defective axle dislocation, dangerous fuel tank placement, and alternative designs that would have prevented these failures. After attending this presentation, attendees will be better equipped to recognize and analyze heavy truck crashes and fires with the objective of establishing accurate cause and effect for occupant injury and property damage.

Impact on the Forensic Science Community: This presentation will impact engineers, scientists, criminologists, attorneys, pathologists, police, and others involved in the forensic aspects of traffic accident investigation and reconstruction and vehicle fire investigation, especially in heavy trucks.

In this case study, a restrained driver was operating a day cab tractor-trailer on a familiar, flat, straight freeway when, for unknown reasons, the vehicle drifted to the right off the roadway, sideswiped a tree, broke off the front axle, ruptured the side-saddle diesel fuel tanks, and burned. The driver had no collision-related injuries, yet died due to the fuel-fed fire. Postmortem blood analysis revealed the driver's carboxyhemoglobin level was extremely high, consistent with pre-crash loss of consciousness, which is covered in a separate presentation. Initial investigation of the subject truck revealed that in the relatively low-velocity offset front collision, the poorly designed front axle of the tractor had sheared off and was displaced rearward, allowing the front tires and wheels to rupture the exposed fuel tanks. This spewed a large volume of atomized fuel, which ignited and fatally burned the uninjured driver. Several hypotheses regarding the cause of vehicle axle separation, fuel tank rupture, and resulting fire were investigated, evaluated, and tested.

The late-model subject truck had virtually identical fuel tank placement as trucks produced in the early 1940s. Diesel fuel tank placement and guarding varies widely, depending on the size of the truck as well as the safety regulations in the country of operation or origination. In many areas of Europe and Asia, such heavy truck diesel fuel systems are guarded and/or completely relocated for impact protection. Fuel leakage prevention and ignition countermeasures had been developed over 50 years ago to reduce fire risks in heavy trucks. However, the heaviest class 7 and 8 trucks and vocational vehicles operated in the United States typically utilize large-volume, unguarded side-saddle type fuel tanks attached outside one or both frame rails, without check valves or any means to prevent impact-related leakage. Side-saddle tanks are usually in close proximity to the cab and any occupant egress paths, as were the tanks in this case. Such exposed fuel tanks are generally adjacent to unguarded batteries and cables mounted outside the frame rails. This creates an extraordinary proximity of very vulnerable, constantly exposed large volumes of fuel adjacent to high-energy ignition sources that are subject to collisions by other vehicles and fixed objects, which also are often adjacent to vehicle occupants. The exposed, dangerous location of such heavy truck fuel tanks clearly violates many long-established principles of reasonably safe vehicle fuel system design.

Crashworthy fuel system designs have been determined by crash test research published since at least the early 1960s that discovered dangerous flaws in ground vehicle and aircraft fuel tank location and materials. Research experience includes participation in the Department of Defense and National Highway Traffic Safety Administration (NHTSA) ground vehicle and aircraft fuel system safety research in the 1970s and 1980s. This was performed per the military Crash Survival Design Guide and Federal Motor Vehicle Safety Standard (FMVSS) 301, as well as defect investigation crash tests on the Ford® Pinto®, General Motors® side-saddle tank pickups, school buses, and several other vehicles that led to safety recalls. The FMVSS, including 301 for fuel system integrity, tend to be significantly less robust or non-existent for larger vehicles with Gross vehicle Weight Rating (GVWR) over 10,000 pounds. There are no crash-related fuel system safety standards for heavy trucks, which is made worse by the myth that "diesel fuel does not burn" in collisions.

The current investigation included the fabrication, installation, and testing of a relocated, far safer, equal capacity fuel tank on an exemplar day cab tractor matching the subject tractor, based on principles established in the 1960s and 1970s. This study also discovered production alternative design fuel tanks and tank inserts that could have prevented the subject fire. The investigation, analysis, and testing involved in this case will be presented and discussed.

Heavy Truck Fire, Truck Fuel System Defects, Heavy Truck Crashworthiness

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