D20 Non-Collision Moving Vehicle Fire Caused by Escape of Exhaust Heat and Combustion Gases Due to Muffler Design and Materials Defects

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After attending this presentation, attendees will understand how a wide range of forensic investigation and analysis techniques, ranging from fire cause and origin to metallurgical analysis of materials and welding to analysis of how and why fire can spread rapidly, can be employed.

This presentation will impact the forensic science community by describing the methodology utilized to investigate a non-collision fire involving a moving vehicle which had demonstrated no known pre-fire operational defects or damage.

A two-door utility vehicle in original equipment manufacturer (stock) condition ignited and rapidly burned while being driven at normal highway speed on a paved road. There was no evidence of a collision, other pre-fire vehicle damage, or operational malfunction of seats or doors. Despite immediate rescue efforts by the initially uninjured driver, two conscious, initially uninjured children restrained in safety seats in the rear seat of the vehicle died due to the extremely rapid spread of the fire. Forensic examination of the vehicle showed a burn pattern consistent with a fire originating from the carpeted interior floor pan area between the front and rear seats. The fire then spread via burning of the adjacent front and rear seats. There was a corroded hole in the floor pan directly below the area of fire origination. Below the floor pan hole was the muffler, which showed clear evidence of long-term pre-fire deterioration, including a missing heat shield. This allowed exhaust gases to heat, corrode, and eventually penetrate the floor pan and the flammable interior components above the hole. The muffler utilized a combination of poor design, inferior construction techniques, and inferior materials that caused or contributed to the escape of hot, corrosive exhaust gases, as well as allowed those gases to strike the unprotected floor pan for an extended period of time. Because the hole in the floor pan was covered by carpeting and insulation, these defects were not noticeable to the operators of the vehicle prior to ignition.

Vehicle interior materials were apparently certified by the manufacturer to be in compliance with the flame resistance requirements of Federal Motor Vehicle Safety Standard (FMVSS) 302; however, these materials were not capable of handling the prolonged heating caused by the hot exhaust gases, particularly when applied to the underside of the padded carpeting. This is not a heat vector typically anticipated by FMVSS 302, but it is certainly foreseeable given the close proximity to hot exhaust components. Once ignition conditions were reached, the spread of the fire was extremely rapid. Despite immediate attempts to remove the two rear-seated occupants, they both perished in the fire.

There have been limited research studies on the effects of exhaust system heat, particularly that generated by catalytic converters or mufflers, causing fires related to flammable materials such as dry vegetation, dead leaves, and paper on the ground under parked or running vehicles; however, this case involves a type of exhaust system failure and adjacent vehicle structural/materials failure which is substantially different. The extremely rapid onset of fire illustrates that vehicle interior materials may be far more dangerous when subjected to some types of foreseeable ignition sources than were anticipated by FMVSS 302.

The extremely rapid spread of fire in the interior of a vehicle that was supposedly compliant to FMVSS 302 is also notable. Based on available information, this type of fire normally does not result in a loss of life, therefore it likely does not receive as much attention from automotive manufacturers or safety regulators as other types of vehicle fires. Emergency egress from a vehicle, particularly rear seated occupants, is a commonly overlooked aspect of passenger protection.

The educational objectives of this presentation will be relevant to forensic practitioners in the engineering sciences, fire and arson investigation, vehicle design, accident investigation, criminalistics, jurisprudence, and pathology, with potential interest to those in toxicology and general forensic sciences.

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