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Forensic Investigation of Vehicle Fires in Structures

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Abstract

Cars and trucks experience fires due to a variety of causes, and the loss is generally limited to the value of the burned vehicle. When a vehicle defect or recent repair is suspected to be the cause, the modest economic value of the loss does not usually warrant a Forensic Engineering investigation and the expense of litigation.

However, when vehicles burn inside a garage or other structure, the value of the loss can be much greater, and a thorough investigation by Fire Investigators and Forensic Engineers is often warranted to support potential litigation.

This paper will review some cases in which a vehicle burned within a garage, causing damage to the structure. In some of those cases, the cause was clearly identified and successfully litigated. Challenges and strategies related to those cases will be discussed.

Keywords

Fire, Ignition, Origin & Cause, Surface Ignition, Oil, autoignition

Motor vehicles carry a large quantity of combustible materials, including fuel, oil, transmission fluid, steering fluid, brake fluid, and coolant, as well as fabrics, insulation, plastics and rubber. Importantly, motor vehicles also carry their own sources of ignition. Given the many sources of fuel and potential sources of ignition, it is not surprising that some vehicles burn. One in every 1,000 vehicles ultimately burns from non-crash related causes.[1]

When a vehicle burns at the side of a road, it usually results in a total loss. If insured for fire, insurance companies usually pay the claim and close the file. If the vehicle is brand new or the fire was suspected to be caused by recent repair, a Forensic Engineer may be engaged to determine whether there is evidence of the cause. In most cases, the value of the loss is too little to justify extensive investigation and the costs of litigation.

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When a vehicle burns inside a garage, the economic value of the loss goes up by an order of magnitude or more.

Fire Origin & Cause Investigators usually have the expertise to determine the location of fire origin, based on burn patterns. Determination of the cause is usually more difficult. Factors that may play an important role in determining the cause:

- Witnesses to origin?
- Condition of evidence
- History of similar events
- Recalls, Defect investigations
- Repairs, maintenance

If the Fire Investigator places the fire's origin within the vehicle, special expertise is required to determine the cause. Multiple investigators may be needed with overlapping areas of expertise, including:

- Fire investigation
- Automotive Engineering
- Combustion science
- Electrical engineering
- Materials science
- Research

Fires tend to destroy or obscure the evidence, so a bit of luck may also be needed.

Hot or cold?

Vehicle fires have been known to occur when a vehicle was parked, with the engine shut off for hours. If a vehicle burns when the engine is cold, the focus of investigation is electrical. Such fires are usually the result of an unintended electrical path, generating heat. Other potential electrical sources of ignition in the garage must also be investigated and ruled out, regardless of the suspected cause.

Hot engines can be a source of ignition under certain conditions. Although there are multiple combustible fluids in an engine compartment, and leaks are foreseeable, a special combination of factors and conditions must coincide to produce fire. Anyone who has tried to light a campfire on a windy day knows how hard it is to maintain a flame in the wind. The same is true for vehicles underway on the highway.

However, when a vehicle is parked in a garage and the engine shut off, a unique combination of conditions arises, including:

- Under-hood airflow stops
- Water pump stops
- Maximum under-hood temperature
- Everything is pre-heated

During the first 10 to 15 minutes after shutting the engine off, engine temperatures rise. In a preheated environment with no external airflow, conditions are right for hot surface ignition of oil. If a flame should occur, it is likely to persist (and grow) so long as fuel and oxygen are available.

Case study No. 1

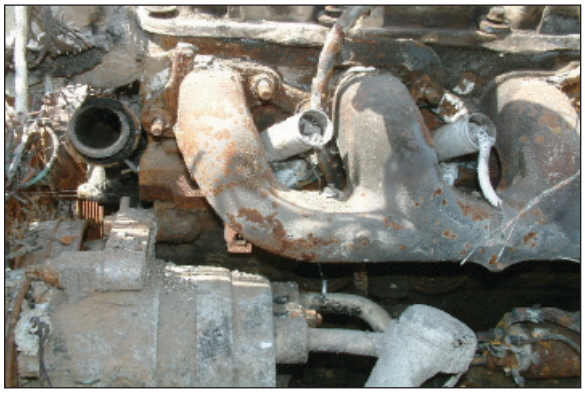
A Buick Regal with 3.8 Liter engine burned in a garage, involving another vehicle and the entire house. The owner reported seeing flames coming from the engine compartment about 10 minutes after being parked in the garage. Shortly after the fire, the owner received a recall notice on the Buick, for a problem resulting in engine fires. The Fire Origin & Cause Investigator identified the origin as the same area identified in the recall.

The recall problem was described as follows:

> "IF THE MANIFOLD IS HOT ENOUGH AND THE OIL RUNS BELOW THE HEAT SHIELD, IT MAY IGNITE INTO A SMALL FLAME AND MAY SPREAD TO THE PLASTIC SPARK PLUG WIRE CHANNEL AND BEYOND INCREASING THE RISK OF AN ENGINE COMPARTMENT FIRE"

When the burned vehicle was inspected, no evidence of an oil leak or fire appeared inside the heat shield or the exhaust manifold runners beneath the heat shield. At the time of the inspection, this investigator did not recognize evidence of the cause.

Inside of heat shield



Exhaust runners

Following inspection of the vehicle, the author received the deposition transcript of a General Motors engineer. He was leader of the team that investigated reports of engine compartment fires in 3.8 Liter engines. His description of the specific evidence pointing to the recall problem included a build-up of "caramelized oil" where it leaks past the front edge of the valve cover gasket, and dark stains under the leaking gasket as evidence of the leak path. A more robust replacement gasket design was implemented in the recall. The evidence of an oil fire was not located "below the heat shield" as mis-directed by the recall language. The evidence was below and adjacent to the leaking gasket.

Going back through our photos, we found the "caramelized oil" right where the GM engineer said it would be. This evidence was strong enough to identify the cause as being the recall problem – a leaking gasket.

Case No. 2

Shortly after reading the GM engineer's deposition, the author was asked to investigate another fire in a Buick 3.8 Liter vehicle, that burned down the house. All the facts were consistent with the recall problem, but this model had not been recalled. The owner witnessed fire in the engine compartment about 15 minutes after pulling into the garage. The Fire Investigator placed the origin at the front of the engine.

Evidence of caramelized oil on the cylinder head and exhaust manifold was consistent with the specific evidence described by the GM engineer. Another bit of evidence was the dark stain on the gasket sealing surface where the leak occurred. Although this model was not part of the recall, its valve cover

The burn pattern indicates origin at the front of the engine

Dark deposits and stains are evidence of an oil leak

and gasket were the same parts used in the recalled models. The more robust gasket design was the replacement part for all models.

The first case generated many thousands of pages of discovery documents from GM, including their own scientific study of hot surface ignition. They confirmed that under some conditions, a drop of oil will ignite when dropped onto a hot exhaust manifold. If the resulting flame is not blown off and finds additional fuel (such as plastic trim) it can persist for several minutes and propagate into an engine compartment fire.

Hot Surface Ignition

Ignition of combustible materials under the hood is complex and sometimes counter-intuitive. Experiments to determine the surface temperature sufficient to ignite a drop of fuel can produce surprising results. While it might be expected that gasoline will ignite before oil, the opposite is true. Oil will ignite on a hot surface at about 600 °F, while it takes 1300 °F to ignite gasoline. These temperatures are different from autoignition temperatures determined using pre-mixed fuel/air samples.

This difference in ignition properties may be explained by the differences in latent heat of vaporization, diffusion rate with air, fuel vapor specific gravity, flammability limits, effect of pre-heating, and others. The important result is that oil leaks can start engine compartment fires. The leaks are unlikely to ignite while the vehicle is underway, because a small flame will tend to be blown out with any significant airflow. Parked in a garage, conditions are right for hot surface ignition, for about 10 to 15 minutes.

In the GM 3.8 Liter engine, an oil leak can accumulate and “caramelize” into a crusty deposit. After repeated drops of oil form a crust, that crust acts as a flame-holder with a reservoir of oil. Like a candle, the deposit can act as a wick to hold the flame and vaporize oil.

Conclusions

Based on the facts of Case No. 1 and our vehicle inspection, we were not able to conclude a cause and effect sequence. We were misled by the recall language “...below the heat shield...” and at the time, could not be reasonably certain of the cause. An appropriate person was deposed and appropriate questions were asked. The descriptions of caramelized oil and other substantive evidence, together with many photos from the GM internal case investigation files, was important and became persuasive in both cases.

Litigants sometimes send voluminous discovery documents, hoping that adversaries will be discouraged. Although reviewing voluminous files is not a pleasant task, it may be productive. Product problems that rise to the level of a recall involve many people and generate many documents. Finding the right people and getting answers to appropriate questions requires persistence.

Evidence of the cause of a fire is often subtle and may be easily overlooked. Reference to similar fire investigations can be a valuable tool, especially when the cause and supporting evidence has been well documented.

Reference

1. Cooley, P., "Motor Vehicle Non-Crash Fires," SAE Technical Paper 810012, 1981