C20 Analyzing a Fuel Circuit to Prevent Post-Accident Fuel Fed Fires

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The goals of this presentation are to analyze an OEM fuel delivery system for functionality specifically related to fuel cut-off in the event of an accident. Then to show an alternative cut-off system utilizing an inertial switch that decreases the chances of an unwanted post-accident fuel run-on.

Theory of the Analysis: The case that prompted this analysis involved a 1995 small pickup truck. The subject vehicle received a frontal impact from the rear-end of an overturned 1988 sedan that had lost control and already impacted one other vehicle. After the impact, the driver of the pickup was trapped inside. A fire started, became obviously fuel fed, and the driver was burned inside of the subject vehicle.

The first question that arose was whether the fuel came from the subject vehicle or the sedan. Careful examination revealed that the fuel did not come from the sedan, as first thought, but from a damaged fuel line in the pickup's engine compartment. The subject accident was so severe that the pickup's engine was displaced rearward and downward into the firewall. The impact with the firewall broke a hexagonal fitting on the rear of the engine where the fuel line attached. This discovery led to tests on an exemplar vehicle and the construction of a model to determine under what conditions would the subject fuel system continue to circulate fuel.

The stated operating pressure of the subject fuel system is 37-45 psi, as measured between the fuel filter and the engine. However, tests on an exemplar vehicle showed that the fuel system would continue to idle (circulate gasoline) with an operating pressure of approximately 10 psi, well below its stated operating pressure. Additionally, at first the subject fuel delivery system's main shut-off mechanism appeared to be the oil pressure switch (which is a separate hydraulic circuit from the fuel pressure circuit). However, subsequent exemplar vehicle tests showed that the oil pressure switch did not even need to be connected for the engine to run and fuel to circulate, as long as the circuit was primed. This confirmed that all of the control was through the subject vehicle's engine computer and fuel pump relay.

In the event of crash-induced fuel system damage, the fuel pump can continue to run under the following circumstances:

1. The engine continues to idle after the crash.
2. The (redundant) oil pressure switch contacts become shorted.
3. The prime connector becomes shorted to a positive battery line with the engine not running (i.e., the fuel pump relay is deactivated).
4. The PCM sends an errant signal.
5. The fuel pump relay sticks.

None of the avenues for emergency fuel shut-off in the subject vehicle involved directly removing power to the fuel pump.

A well known and defined system existed in the industry at the time the subject vehicle was designed and manufactured that would remove power from the fuel pump in the event of a crash. This system utilized an inertial cut-off switch inserted into the fuel pump's primary power supply line. These inertial switches can be calibrated to each vehicle, and, when activated (opened), they directly disconnect power supply to the fuel pump, regardless of whether or not the engine is still turning. The simple insertion of this switch dramatically reduces the amount of fuel that can be lost through a crash-induced fuel system leak. The difference in the amount of fuel lost between the two systems was documented on video through the use of a model.

Discussion: As was shown and documented in testing, the insertion of a simply device can have a major effect on unwanted post-crash fuel run-on. This device has been used by other manufacturers in their production vehicles for many years and has proven its functionality. By removing power from the source of the fuel flow, one has reduced or even eliminated the possibility of fuel run-on. The model that was built showed not only the effect of the addition of the inertial switch, but also the ease in which it could be added to the fuel system circuit.

Fuel System, Fire, Fuel Run-On

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