Auto Investigation #3

ENGINEERING REPORT

PREPARED FOR:	**INSURANCE COMPANY #1**
ATTENTION:	**MR. ANDY MOORINGTON**

INSURED:	**DAVE'S AUTO SERVICE**
DATE OF LOSS:	**NOVEMBER 2001**
LOSS LOCATION:	STORAGE FACILITY #1 INDIANAPOLIS, IN
POLICY NUMBER:	N/A
CLAIM NUMBER:	<omitted>
IC1 FILE NUMBER:	<omitted>

INTRODUCTION

On November 2001, a fire occurred in the engine compartment of a 1997 Pick-up Truck owned by Mr. Dana Woolrich. At the time of the fire, Mr. Woolrich reportedly was talking with his wife in a school parking lot while the engine was idling. Mr. Woolrich had placed the truck in gear and began accelerating when his wife noted flaming liquid emanating from the engine compartment. She informed her husband who immediately stopped the truck. There were no reported injuries.

On October 2001, the subject pick-up truck had been serviced at the insured's service facility, Dave's Auto Service (Dave's) located in Indiana. Dave's had replaced the intake manifold gasket, thermostat, and serpentine belt. All items were located at the top and front of the engine. The service involved partial disassembly of the vehicle's fuel system and fuel injection controls and sensors.

The pick-up truck had reportedly operated in a satisfactory manner since the service. On the day of the event (i.e., November 5, 2001), the owner reported that he smelled a "gasoline smell" in the cab of the pick-up while he was ascending a hill prior to arriving at the school.

On December 2001, Mr. Andy Moorington of Insurance Company #1 contacted Investigation Company #1 (IC1) and requested IC1's assistance in determining the origin and cause of the fire. Mr. Arthur Peterson, IC1 Fire Investigator, was assigned to conduct the origin and cause investigation.

On December 2001, Mr. Peterson contacted the author of this report, Scott Jones, Mechanical Engineer, CFEI of IC1's office to assist in the fire cause determination. Specifically, an investigation was to be conducted to determine whether the recent repairs had causation in the event.

The results of the engineering investigation are contained in this report. Refer to Mr. Peterson' report, available under separate cover, for scene specific and witness information.

OBSERVATIONS

On December 2001, the author conducted an inspection of the subject vehicle at Storage Facility #1 located in Indianapolis, Indiana. Mr. Donald Sutherland, I.C. of IO Associates, MI; Mr. Gary Worth, CFEI of Worth Forensic Services, Inc. in IN; and Mr. Charles Lowe of Yes Auto in IL, were in attendance for the entire inspection. Mr. Sutherland represented

the interests of the manufacturer of the subject vehicle; and Mr. Worth and Mr. Lowe represented the interests of the vehicle owner.

The subject vehicle, a 1997 pick-up truck was identified by Storage Facility #1 as stock number <omitted>. The author verified the VIN number from the dashboard plate as <omitted>. At the time of the inspection, the vehicle had 55,000 miles by odometer reading.

The exterior of the vehicle was in good condition. *Photograph 4* shows a front view of the vehicle, and *Photograph 5* shows an area of bubbled and missing paint located on the driver's side central portion of the hood. The driver's side of the vehicle is shown in *Photograph 6*. The passenger's side of the vehicle is shown in *Photographs 7 and 8*.

The top, rear portions of the V-8 engine and engine compartment were extensively damaged. *Photographs 9 and 10* show passenger's side and driver's side views of the top of the engine, respectively. *Photograph 11* shows charred and partially consumed electrical conductor insulation along the wiring harness spanning the firewall (i.e., directly behind the engine).

Photograph 12 shows a forward-looking-aft view along the top, center of the engine. The rubber hoses and elastomer materials located at the front of the engine were lightly damaged in the event.

Fuel Injector System Damage

The fuel injection system and wiring along the driver's side of the intake manifold was extensively damaged. The plastic fuel injector system distribution manifold (fuel rail) was discovered melted and partially consumed as shown in the lower part of *Photograph 13*. The fuel injection system Maximum Absolute Pressure (MAP) and Throttle Position Sensor (TPS) conductor leads were extensively damaged as shown in *Photographs 13 and 14*, respectively.

Photograph 15 shows the in situ configuration of 2 of 3 TPS conductors that were located immediately adjacent to the (melted) driver's side fuel rail. The conductors had extensive arc marks along an approximate 1½-inch span as shown in the photograph.

The engine compartment and passenger's compartment fuse boxes were checked for blown fuses. Neither the engine compartment (*Photograph 16*) nor the passenger's compartment (*Photograph 17*) fuse boxes had any blown fuses.

The fuel rails were supplied with pressurized fuel from a fuel pump located within the fuel tank via a flexible hose section. The end of the fuel hose connected to the mid span of the driver's side fuel rail and was secured by a metal clip.

Exemplar Fuel Hose/Fuel Rail Connection

An exemplar 1997 pick-up truck (*Photograph 28*), identified in the Storage Facility #1 inventory system as stock number <omitted> was discovered within the storage yard and utilized as an exemplar for the inspection.

Photograph 29 shows the exemplar fuel hose/fuel rail connection completed as designed with the yellow tipped clip (*Photograph 33*) fully inserted into the plastic fuel rail holder. *Photographs 30 through 32* show progressive stages of fuel hose removal from the fuel rail following removal of the yellow tipped retaining clip. The close proximity of the TPS conductors to the fuel rail should be noted in the photographs.

Affected Fuel Hose/Fuel Rail Connection

At the start of the inspection, the fuel hose connection to the fuel rail was discovered separated on the affected vehicle as shown in *Photograph 34*. The plastic housing for the fuel hose retention clip was partially melted away as shown in the photograph with the fuel hose retention clip melted *into* the fuel rail (*Photograph 18*). The fuel hose position had been disturbed by unknown party(s) prior to the author's inspection and further comment will be given in the Discussion/Conclusions section of this report.

With the approval of all parties at the inspection, the author had Mr. Lowe remove the metal fuel hose retention clip (*Photographs 20 and 21*) and the melted fuel rail segment in the vicinity of the fuel hose connection point. *Photograph 19* shows the in situ arrangement of the fuel rail and rubber o-ring still mounted in the rail upon removal of the metal clip.

Photographs 22 and 23 show progressive views of the top surface (i.e., the side of the fitting facing away from the engine) of the fuel hose fitting. *Photograph 24* shows the bottom surface (i.e., the side of the fitting situated toward the engine) of the fuel hose fitting. *Photograph 25* shows the portion of the driver's side fuel rail removed by Mr. Lowe with the undamaged rubber o-ring still in place (*Photograph 26*).

DISCUSSION/CONCLUSIONS

As noted, the subject fuel hose was discovered withdrawn from its associated connection point in the driver's side fuel rail. Although the fuel rail was extensively melted at the connection point, it was discovered that the rail had melted *around* the steel end of the fuel connection hose.

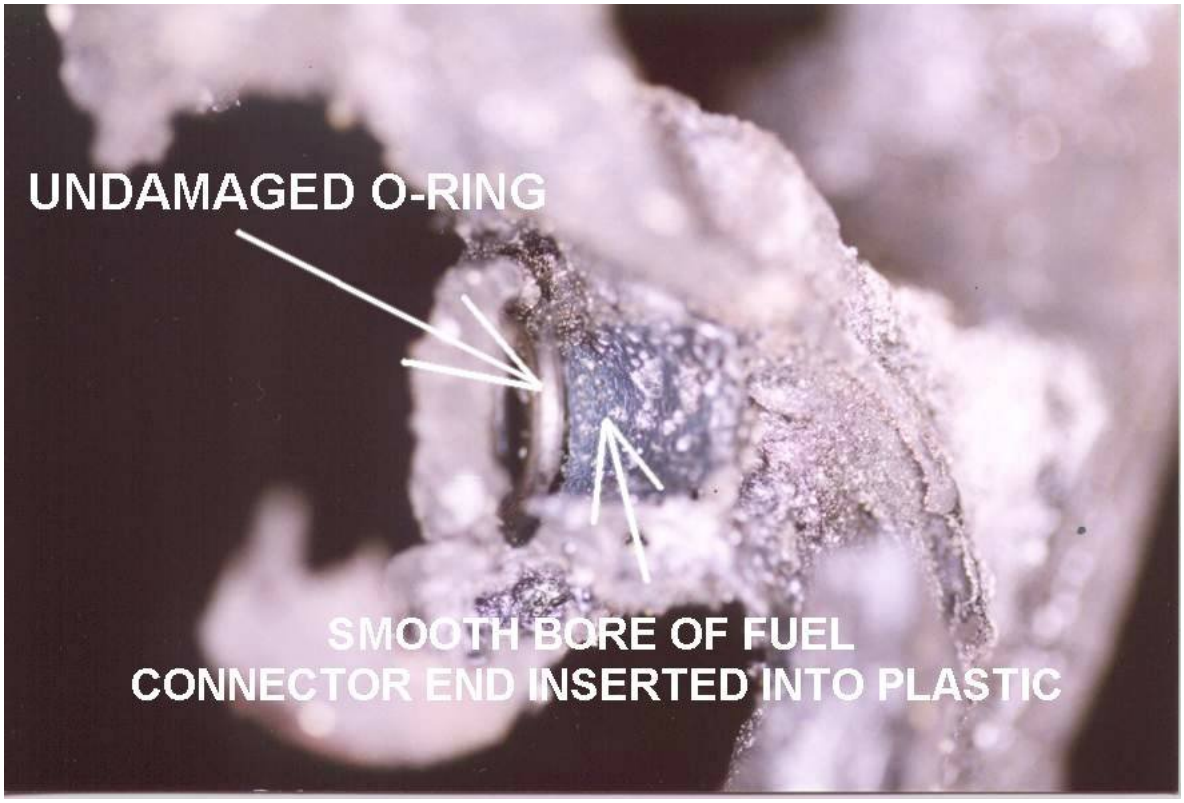

Figure 1 - FUEL RAIL REMNANT SHOWING O-RING AND FUEL HOSE END IMPRESSION

Figure 1, which was derived from *Photograph 26*, shows two evidence items pertaining to the insertion of the fuel hose connector end into the plastic fuel rail. The first item pertains to the nearly undamaged condition of the fuel sealing o-ring in the fuel rail. The o-ring, which is composed of low melting point rubber, was discovered nearly undamaged as shown in ***Figure 1***.

Had the fuel hose separated from the fuel rail at the connector *prior* to the fire, the fire would have charred or consumed the o-ring. Instead, the o-ring was protected from the fire by the wide flange of the (inserted) fuel connector. Reference *Photographs 22, 23, and 24* for flange configuration that mates with the o-ring.

The second item shown in ***Figure 1*** is the conspicuous smooth impression in the plastic fuel rail of the steel fuel hose end fitting. The plastic fuel rail had melted *around* the fuel fitting. Had the fuel hose connector not been in place before the fire, the impression of the steel fuel hose end would not have been evident.

It is therefore believed that the fuel hose connector end was fully inserted into the fuel rail (i.e., against the subject o-ring) prior to and during the subject fire. It is also believed that an unknown party(s) removed the subject fuel hose from the fuel rail remnant prior to the author's inspection. The fuel hose was discovered continuous and undamaged back to the fuel tank.

Figure 2 (below), developed from *Photograph 23*, shows the top of the fuel connection positioned as installed relative to the fuel rail.

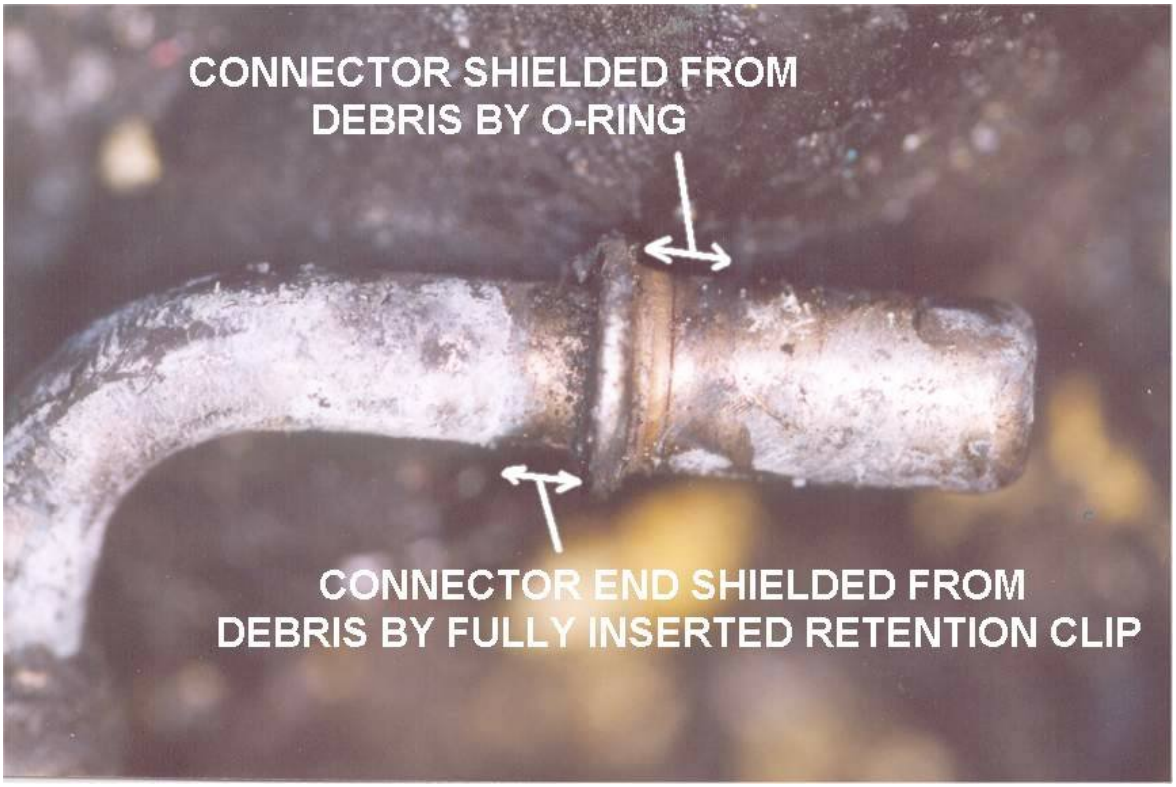

Figure 2 - FUEL HOSE END DEBRIS PATTERNS

As can be seen in ***Figure 2***, the top periphery of the fuel hose connector was shielded from fire extinguisher debris. The only protection afforded to the region would have been from a fully inserted fuel hose retention clip. The retention clip was properly seated against the

tube end (i.e., fully installed) to create the observed pattern. In addition, the tube end shows witness marks at the location of the fuel rail o-ring.

Figure 3 (below), developed from *Photograph 24*, shows the clean insertion length (i.e., into the fuel rail) that was directed toward the engine and not subject to fire extinguisher debris. Note: the fire penetrated the fuel rail and some of the fire extinguisher debris was discovered on the outward facing surface of the connector (reference ***Figure 2***).

Figure 3 - LOWER (ENGINE SIDE) OF FUEL HOSE CONNECTOR

It should be noted in ***Figure 3*** that there were no markings from the retention clip because the retention clip did not pass around the lower periphery (i.e., the engine facing side) of the connector.

It is therefore believed that the subject fuel hose retention clip (reference Photographs 20 and 21) was properly installed and fully seated against fuel hose steel connector prior to and during the fire.

The fuel injector electrical stranded wiring, the MAP sensor wiring, and the TPS stranded wiring were closely inspected using a 10x illuminated Coddington magnifier to detect arc faults along their lengths. Substantial arc marks and copper strand melting were discovered in two of the three stranded conductors from the TPS sensor in the vicinity of the plastic fuel rail.

Figure 4 (below), developed from *Photograph 15*, shows the arc and melting damage to the stranded small gage TPS conductors. It is believed by the author that the conductors operated at a 5 Volt DC potential, and direct conductor-to-conductor faulting caused the damage.

Figure 4 - THROTTLE POSITION SENSOR STRANDED CONDUCTOR FAULTS

Summary

A review of the fire damage in and around the engine compartment of the subject vehicle showed that the most extensive damage occurred in and around the driver's side fuel injection manifold (i.e., fuel rail).

By observation of the debris markings of the fuel hose connector and observation of the undamaged fuel rail o-ring, it is believed that: 1) the fuel hose connector end was fully inserted into the fuel rail and 2) the fuel hose retention clip was fully and properly installed before and during the fire.

Evidence of a substantial electrical fault was discovered in two of three Throttle Position Sensor stranded copper conductors that were located upon and directly in contact with the driver's side fuel rail.

It is therefore believed that the ignition source for the fire was electrical arcing between the Throttle Position Sensor conductors. The first fuel to the fire was the electrical insulation surrounding the faulted conductors. Once the insulation around the conductors was ignited, it is believed that the fire quickly extended to the chafe guard around the conductors and to the adjacent driver's side plastic fuel rail. The report of a sudden, catastrophic fire resulting from the release of pressurized gasoline is consistent with witness reports.

It should be noted that no over-current protection devices operated during the event, and therefore the arcing was most probably sustained for a substantial period before and during the event. The conductors showed no knife or external injury marks that may have been caused by the October 2001 maintenance.

There was no known service or replacement of the affected conductors by Dave's Auto Service during the October 2001 maintenance. It is believed that Dave's properly re-assembled the fuel supply system in the subject vehicle and had no causation in the fire that occurred on November 2001.

The above conclusions are based upon information reviewed to date, plus general engineering knowledge and experience. Information reviewed at a later date may warrant modifying or augmenting the conclusions.

We appreciate the opportunity to work with you on this evaluation. Pending further direction, this file is considered closed. Please let us know whether we can be of further assistance to you.

Sincerely,
Investigation Company #1

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