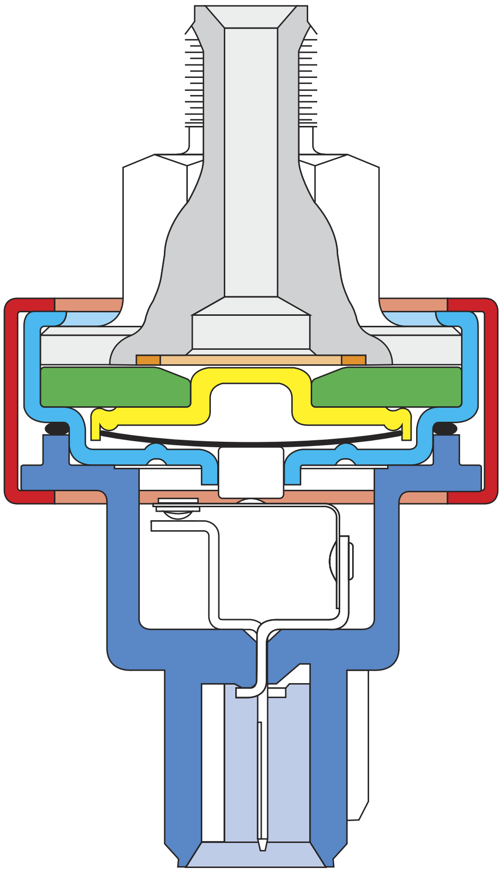

ANALYSIS OF A FORD SPEED CONTROL DEACTIVATION SWITCH FIRE.

BY JEFFERY T MORRILL, CFI, CVFI; MARIETTA, GEORGIA—The investigation of a vehicle fire is often a complex and daunting task. Occasionally, when a situation arises that is so widely publicized as the recent recall of nearly four-million Ford vehicles, even the experienced fire investigator tends to view these losses with a bit of tunnel-vision.

The first step in any vehicle fire investigation is to properly identify the vehicle. Only then can a proper origin and cause investigation proceed. To identify a Speed Control Deactivation Switch (SCDS) fire, the investigator must observe the burn patterns and demonstrate evidence consistent with a fire originating at the driver's side of the engine compartment, followed by the proper documentation, collection and analysis of the evidence.

The initial recall was 99v124 for the 1992-1994 Panther platform (consisting of the Lincoln Town Car, Ford Crown Victoria and Mercury Marquis). This was followed by (Ford 05S28), issued January 27, 2005, listing the 2000 model year F-150 Series including the Expedition and Lincoln Navigator, as well as the 2001 F-150 Supercrew. This recall was expanded September 7, 2005, to include the 1994-2002 model year F-150, 1994-1999 F-250 (light duty) 1994-1996 Bronco, 1997-2002 Expedition, 1998-2002 Lincoln Navigator and the 2002 Lincoln Blackwood. Ford stated that the Speed Control Deactivation Switch in these vehicles may "overheat, smoke, or burn". The link to the recall is: http://www-odi.nhtsa.dot.gov/cars/problems/recalls/results.cfm then NHTSA CAMPAIGN ID Number : 05V017000

Switch Circuitry, Function and Failure

The cruise control system is designed to maintain selected vehicle speed while driving. As part of the cruise control system, there are controls to turn the system on, off and adjust vehicle speed that are typically located on the steering wheel or steering column levers. There are two switches that 'deactivate' the system in response to brake application. The primary switch is an electrical switch, mounted under the dashboard, and responds to the movement of the brake pedal arm. This switch is responsible for energizing the brake lights and deactivating the cruise control system. The second (redundant) switch is pressure activated and mounted on the brake master cylinder. There are two mounting orientations that Ford uses. The most common is a vertical orientation as shown in Figure 1, and the second is a 45 degree down orientation as shown in Figure 2


FIGURE 1


FIGURE 2

The SCDS should only function to deactivate the cruise control if the brake light switch fails; otherwise, this switch is normally closed and carries the electrical load of the cruise control system. The SCDS was manufactured by Texas Instruments design to a Ford specification design. Texas Instruments has stated the switch was only designed to handle a small (1-2 amperes) intermittent DC load. Ford installed the switches in a 15 ampere circuit. Additionally this circuit is energized at all times. Ford stated this was necessary as the switch is in the brake light circuit and must therefore be continuously energized. Figure 3 is a diagram of the switch components.

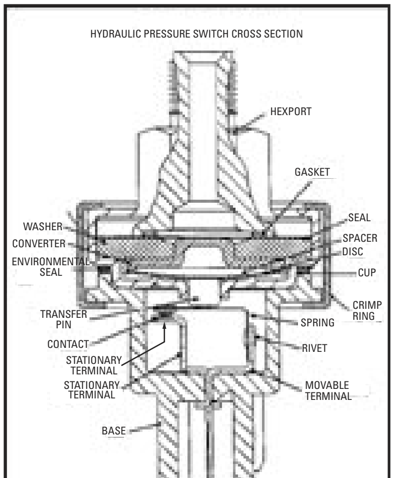

FIGURE 3

Ford has determined that brake fluid can leak by the “kapton” seals and enter the electrical portion of the switch. Ford further stated that the brake fluid intrusion causes corrosion which can lead to a conductive path-to-ground. A three minute video was prepared by Ford and can be found at: http://www.ford.com/en/innovation/safety/resources/cruiseControl.htm

Origin Determination

As an objective investigator, you must inspect every vehicle without presumption and evaluate the evidence on its merits. A typical vehicle investigation starts with an overall view of the vehicle, noting any exterior burn damage. Depending on how long they burned, damage from a SCDS fire may be minor, major or total, such as shown in Figures 4, 5, or 6.


FIGURE 4


FIGURE 5


FIGURE 6

There may be no fire damage visible on the exterior or the vehicle may be “totally” consumed. Of particular importance in these investigations is that if at all possible, the vehicle should be inspected in place. Often, crucial evidence is lost as it falls from the vehicle to the ground and is crushed during vehicle recovery or disposed of after the vehicle carcass has been hauled away. Once the engine compartment is established as the compartment of origin, it should be divided into four quadrants (front driver’s side, rear driver’s side, rear passenger’s side and front passenger’s side) so a comparison of fire damage can be made. Figures 7, 8 and 9, show the differences in fire damage that can be expected between the driver’s side and passenger’s side, as well as the front and rear of the engine compartment.


FIGURE 7


FIGURE 8


FIGURE 9

There may be minimal fire damage at the driver’s side with no damage at the passenger’s side. In more heavily damaged vehicles, the only observable difference may be that there is slightly more hood material in place on the passenger’s side then on the driver’s side. The investigator should consider the attitude the vehicle was setting at during the fire and any other environmental factors that could affect the burn patterns. No one factor alone should be used to determine origin except in the rare case that there is only fire damage at the switch itself.

Arc mapping of the engine compartment wiring can be used as a tool to assist the investigator in determining whether any identifiable electrical activity occurred on the driver’s side of the engine compart ment. Again, this alone does not mean the switch failed and started the fire. It is only an indicator that there was electrical activity on the driver's side of the engine compartment prior to the battery being depleted. The identification of the areas of electrical activity can be marked with a colored ribbon so as to show better in a photograph. Figures 10, 11, and 12, are examples of the identification of electrical activity and how it can be marked.

FIGURE 10

FIGURE 11

FIGURE 12

Based on the inspection so far, the investigator should have a working hypothesis about the origin of the fire at the Speed Control Deactivation Switch and be prepared to locate and document the switch remains.

Figure 13 is a view of an undamaged SCDS mounted vertically on the forward end of the master cylinder.

FIGURE 13

Switch Identification and Collection

If the switch is still completely intact, in its pre-fire position on the end of the master cylinder, it is recommended that the entire master cylinder be removed and retained. This is the easiest way to recover the switch without any further physical damage. If the wires are still attached, they should be cut back a distance away from the switch. A switch that has not been detached from the master cylinder will typically look like Figure 14.

FIGURE 14

Often the electrical (base) portion of the switch will be detached from the hexport (body). The electrical portion may still be attached by the wiring or may have fallen to the inside of the driver's side front tire. A hexport with a detached electrical section may look like the one shown in Figure 15 (the electrical portion is hanging over the master cylinder and still attached by one wire).

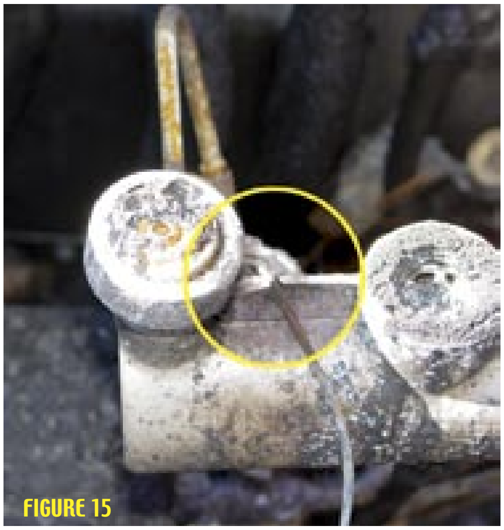

FIGURE 15

When the fire reaches sufficient intensity, the master cylinder will fail, and the switch parts will fall to the ground. Identification and recovery of the switch parts becomes more complex and difficult. Typically, the electrical section will fall ahead of the axle and the hexport will fall to the rear of the axle, but both will be to the inside of the driver's front tire. This area is subject to the actions of fire suppression and vehicle recovery. If the vehicle is slid over the ground, as in a roll-back recovery operation, the switch electrical remains can be crushed. Figures 16 and 17 show the electrical section in the debris under the vehicle.


FIGURE 16


FIGURE 17

Figures 18 and 19 show the electrical section after recovery from the debris.


FIGURE 18


FIGURE 19

The hexport will also be found in the debris as shown in Figures 20 and 21 and after recovery in Figure 22.

Once these items are recovered, they should be placed in a plastic bag, then padded and placed in a metal can to protect the pieces from further harm.

NHTSA has prepared a Go, No-Go Complaint Analysis

SCDS Caused Fire

• Yes: *The following criteria must be met:*

(1) The fire originated in the area where the speed control deactivation switch is located (left-rear corner of the engine compartment, at the master cylinder). This origin point would be evidenced by burn patterns seen in photographs or by eye witness account.

And (2) or (3);

(2) There was evidence of speed control deactivation switch failure prior to the fire (e.g., inoperable speed control, speed control deactivation switch fuse open—sometimes repeatedly, difficulty shifting out of PARK, evidence of brake fluid leakage from the switch) or

(3) Evidence of speed control switch failure discovered during post-fire forensic examination.

• Maybe: *The following criteria must be met:*

(1) The fire originated in the area where the speed control deactivation switch is located (left-rear corner of the engine compartment, at the master cylinder). This origin point would be evidenced by burn patterns seen in photographs or by eye witness account.

Or;

(2) There was evidence of speed control deactivation switch failure prior to the fire (e.g., inoperable speed control, speed control deactivation switch fuse open – sometimes repeatedly, difficulty shifting out of PARK, evidence of brake fluid leakage from the switch)

Or,

(3) Evidence of speed control switch failure discovered during post-fire forensic examination.


FIGURE 20


FIGURE 21


FIGURE 22

• No: *The following criteria must be met:*

(1) The fire originated away from the master cylinder. This origin point would be evidenced by burn patterns seen in photographs or by eye witness account.

Or;

(2) Physical evidence exists that indicate the fire did not start at the SCDS.

Laboratory Analysis

As with any evidence submitted to a laboratory, a proper chain of custody is required. Once the laboratory has the parts, an x-ray of the electrical section will reveal whether the switch has failed internally. Caution must be exercised here as a failure could have occurred at any time in the past and not resulted in a fire. If the switch is failed and the cruise control was working properly, then it can be determined that the failed switch was the likely culprit. X-rays of the switch, such as those shown in Figures 23 and 24 can show the extent of the failure (if it exists).

The use of an exemplary switch in the x-ray can make the identification of the internal components much easier (Figure 25). In a failed SCDS, the x-ray will reveal evidence of melting of the copper contacts.

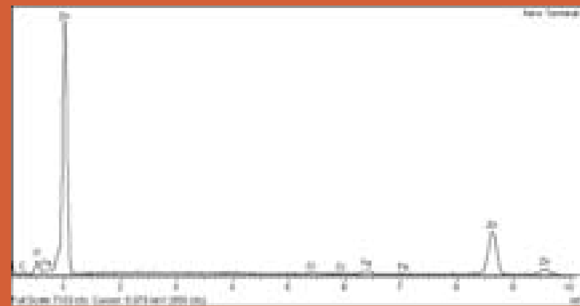

FIGURE 27

A recovered hexport from a failed SCDS will typically look like the one shown in Figure 28. Using the SEM, photomicrographs can be taken of the four quadrants (Figure 29 shows quadrant 1) and the EDS scan of the surface (Figure 30) will show the presence of copper if the electrical portion of the switch has failed.

An SEM/EDS with elemental mapping capability can visually show the location of melted copper on the hexport face (Figure 31). port

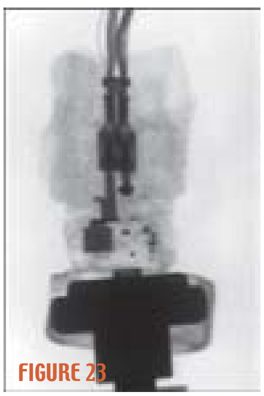

FIGURE 23

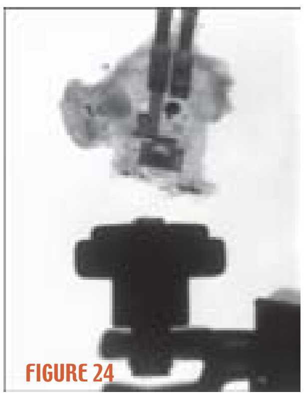

FIGURE 24

FIGURE 25

FIGURE 28

When the electrical section is not recovered, the hexport can still be analyzed. The use of a Scanning Electron Microscope with Energy Dispersive X-Ray Spectroscopy (SEM/EDS) allows the presence of copper to be visualized. In a normally functioning switch, there should be no copper on the face of the hexport. Figure 26 shows a new hexport and Figure 27 is the accompanying EDS spectrum. The zinc (Zn) indicates galvanized steel.

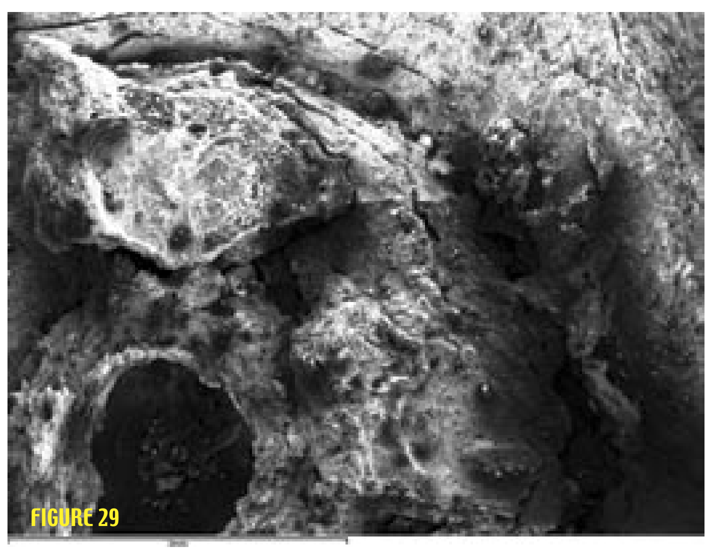

FIGURE 29

FIGURE 26

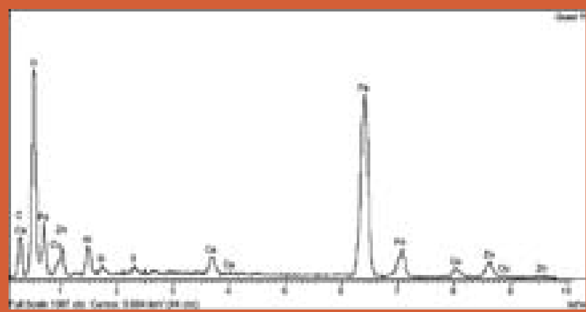

FIGURE 30

A fire from another source will not deposit copper on the hexportface. The contacts are some of the most robust materials in the switch. The housing is plastic and will melt, the ring holding the two switch halves together is aluminum and will melt, and the master cylinder is die-cast zinc (pot metal) and will melt prior to any melting of the switch contacts. The author has seen numerous fires that did not start at the switch (or even in the engine compartment) and the switch contacts have been recovered completely intact even though the master cylinder, connector ring and plastic housing have been destroyed.

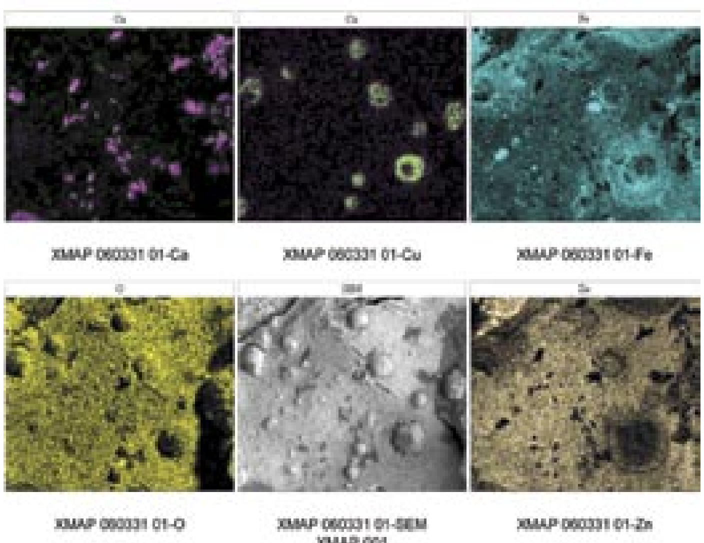

FIGURE 31

Manufacturer's Involvement

NFPA 921, The Guide for Fire and Explosion Investigation, 2004 edition, addresses the issues of spoliation in Chapter 11 at Section 3.5. This section states that the spoliation of evidence may occur if other interested parties are significantly impaired in obtaining the same evidentiary value from the evidence as any other party. It is the responsibility of the investigator to use care to avoid the destruction of evidence. Additionally, it is recognized that it is sometimes necessary to remove the potential causative agent from the scene and even carry out some disassembly in order to determine whether the object did, in fact, cause the fire. There may be cases where the evidence must be removed to protect it from further damage. The investigator will have to use his or her own judgment about notice to Ford Motor Company prior to the removal of evidence. The author's experience is to notify Ford up front about the possibility of liability, and give them the opportunity to respond. Most of the inspections that do not involve any damage other than the vehicle can proceed without Ford's representation. Remember, it is up to you to determine the necessity of the manufacturer's involvement and the extent of documentation that needs to occur. It is not unusual for me to have several hundred photographs of the vehicle including the recovery of evidence. The additional laboratory analysis can add numerous other photographs of the examination of the evidence, including X-ray images and SEM/EDS photographs and spectrums. ●

About The Author

Jeffery Morrill has been investigating fires for Applied Technical Services (ATS), of Marietta, Georgia, for 15 years. He is certified by the International Association of Arson Investigators (IAAI) as a CFI and by the National Association of Fire Investigators (NAFI) as a CFEI, CFII and a CVFI.

Mr. Morrill is one of the staff instructors for the NAFI Certified Vehicle Fire Investigator program, taught at Eastern Kentucky University campus in Richmond, Kentucky.

Additionally, Mr. Morrill is a member of the National Fire Protection Association (NFPA) 921 committee and was heavily involved in the Vehicle Fire Investigation chapter revision in the 2001 edition. Mr. Morrill currently Co-Chairs the task group for the Vehicle Fire Investigation Chapter of NFPA 921, scheduled to be released in 2008. ATS, the largest private laboratory in the Southeast, has the capability to provide both Real-Time X-Ray and SEM/EDS services. Visit us on-line at www.atslab.com