



## FATALITY ASSESSMENT AND CONTROL EVALUATION

### **Flatbed Truck Starts on Its Own, Crushing Auto Body Shop Worker Case Report 14NY013**

#### **CASE SUMMARY**

On March 10, 2014, a 39 year-old male worker of an automobile body shop was fatally crushed by a 2002 Ford F-550 XLT Super Duty diesel flatbed truck in the shop. At the time of the incident, the victim was working alone cleaning the truck in a wash bay. The truck was parked in first gear with the key in the ignition. The parking brake was not set and the wheels were not chocked. At approximately 11:00 am, the victim was cleaning the passenger side of the truck with a pressure washer hose when the truck suddenly rolled forward. It rolled 16 feet and crashed into a paint booth before it stopped. The victim was crushed and pinned between the paint booth door and the passenger side of the truck. A shop worker called 911 immediately. The other workers pulled the door away from the victim and freed him. The emergency medical technicians arrived within minutes. The victim was transported to a hospital where he later died from the crush injuries. A Ford certified mechanic from a local Ford dealer examined the flatbed truck after the incident. The solenoid was replaced by one of the shop's mechanics 20 days prior to the incident. The Ford certified mechanic found that the battery cable on the solenoid was not installed correctly. He identified a short circuit between the battery cable terminal and the signal wire terminal on the solenoid. According to the Ford certified mechanic, the short circuit allowed battery power to activate the starter motor that moved the truck forward. He also found that the truck's neutral safety switch was broken. The broken neutral safety switch did not contribute to the spontaneous starting of the truck.

#### **CONTRIBUTING FACTORS**

- The solenoid was not installed correctly resulting in a short circuit between the signal wire terminal and the battery cable terminal on the solenoid.
- The parking brake of the truck was not set and the wheels were not chocked.

#### **KEY RECOMMENDATIONS**

- *Employers should ensure that workers always set parking brakes and chock the wheels when working on or around a vehicle.*
- *Employers should ensure that a starter is installed properly according to the manufacturer's specifications.*
- *Emergency response staff should set the parking brake, chock the wheels, and disconnect main battery cable to prevent movement of a vehicle when responding to a vehicle emergency.*

- *Manufacturers should consider modifying the design of solenoid terminals to prevent short circuits.*
- *Manufacturers should warn mechanics in the service manual to strictly follow the installation instructions to avoid short circuits when installing a solenoid.*
- *Manufacturers should consider installing a neutral safety switch warning light to indicate the failure of the device.*



*Photo 1. The Ford 550 Super Duty truck suddenly rolled forward 16 feet and crashed into the paint booth when the victim was cleaning the truck in the wash bay (photo courtesy of OSHA).*



*Photo 2. The victim was crushed and pinned between the paint booth door and the passenger side of the truck (photo courtesy of OSHA).*

## **INTRODUCTION**

On March 10, 2014, a 39 year-old worker (victim) of an automobile body shop was fatally crushed by a flatbed truck in the shop. At the time of the incident, he was alone in a wash bay cleaning the truck. The New York State Fatality Assessment and Control Evaluation (NY FACE) staff learned of the incident from the news media and initiated an investigation. The NY FACE investigator conducted a site visit and discussed the case with the compliance officer of the Occupational Safety and Health Administration (OSHA) who investigated the case. The OSHA and police investigation reports were reviewed. A Ford certified mechanic from a local Ford dealer was consulted during the course of the NY FACE investigation.

The auto body shop has been a family business for over 60 years. Four of the eight employees were family members. In addition to body work, the shop also conducts vehicle inspections, transports disabled vehicles, and provides services on engines, transmission, exhaust systems, and tires. The victim was a new hire. He worked in landscaping and building maintenance prior to his employment with the auto body shop. It was the company's first work related fatality.

## **INVESTIGATION**

On the day of the incident, the victim arrived at work at approximately 8:30am. It was the victim's first day on the job. He was assigned to clean and detail the company flatbed truck in the wash bay. The

wash bay was a rectangular booth that was oriented east and west lengthwise. It was approximately 35 feet long and 13 feet wide with the ceiling height of 11 feet. There was a garage door at the west end facing the street. The east end of the wash bay was connected to a paint booth. There was a double door that opened into the wash bay between the paint booth and the wash bay. The door opening was approximately 99 inches wide and 97 inches high.

The flatbed truck, a 2002 Ford F-550 XLT Super Duty diesel truck with a Vulcan Flat Bed was used by the company to transport disabled vehicles. The truck had a 7.3 L Power Stroke V8 Turbo Diesel engine of 250 Horsepower and a five-speed manual transmission. The truck itself weighed approximately 19,000 pounds. The width of the truck was 93.6 inches. The body shop purchased the truck new in 2002. Preventive maintenance was performed by a local truck service shop that specialized in diesel engines. Minor repairs were done in-house.

The starter of the truck burned out approximately 20 days prior to the incident. The flatbed truck driver who was also a shop mechanic purchased a starter unit including a solenoid and a starter motor at an auto parts store and installed it. According to the driver, the truck was operating normally, and he did not notice any problems after the new starter unit was installed.

On the morning of the incident, the flatbed truck driver pulled the truck into the wash bay. He parked the truck in first gear and turned off the ignition. The key was left in the ignition. The truck was parked with its front facing the paint booth door. The parking brake was not set and the truck wheels were not chocked. The victim started washing the truck with a pressure washer hose and soap. He was working alone.

At approximately 11:00 am, a shop technician came into the wash bay through the garage door and saw the truck was rolling forward. The technician yelled to alert others. The truck rolled 16 feet into the paint booth and stopped, smashing the paint booth door and pushing it open backwards into the paint booth. The victim was pinned and crushed between the paint booth door and the passenger side of the truck. There were six other employees on site that day. One worker called 911. The other workers pulled the paint booth door away from the victim and freed him. The emergency medical technicians (EMTs) arrived within minutes. The victim was transported to a hospital where he died from crushing injuries.

After the incident, a Ford certified mechanic from a local Ford dealer examined the truck's starter system and found a short circuit on the solenoid. Figure 1 illustrates a typical automobile starting system that consists of a battery, an ignition switch, a starter relay, a neutral safety switch, a starter solenoid, and a starter motor. When the ignition key is turned to the "start" position, the battery voltage goes through the starter control circuit and activates the starter solenoid. The starter solenoid works as an electric switch: when activated, it closes the circuit and connects the starter motor to the battery and the starter motor cranks the engine and starts the vehicle. As indicated in Figure 1, the short circuit occurred between the battery cable terminal and the signal wire terminal on the solenoid.

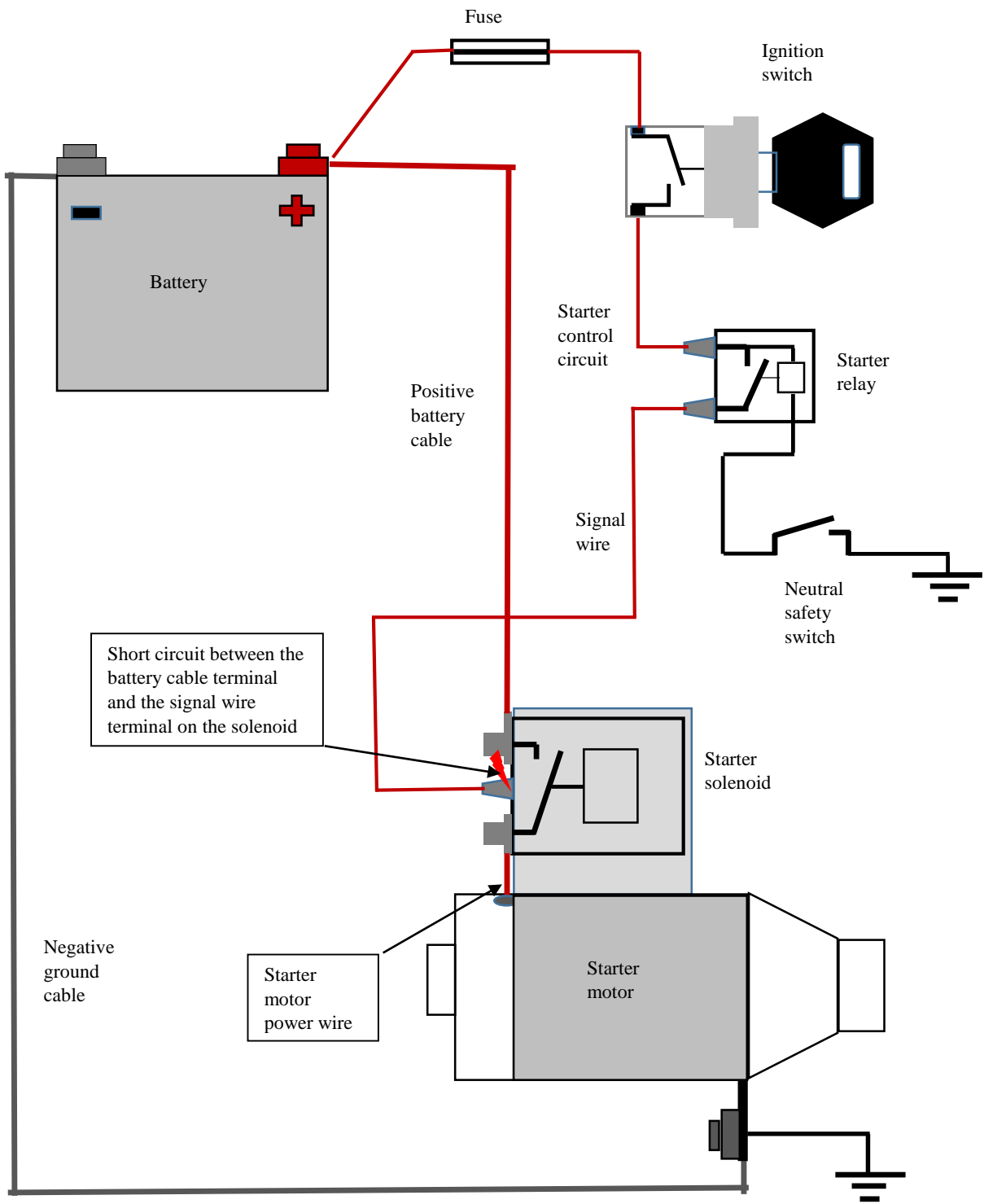
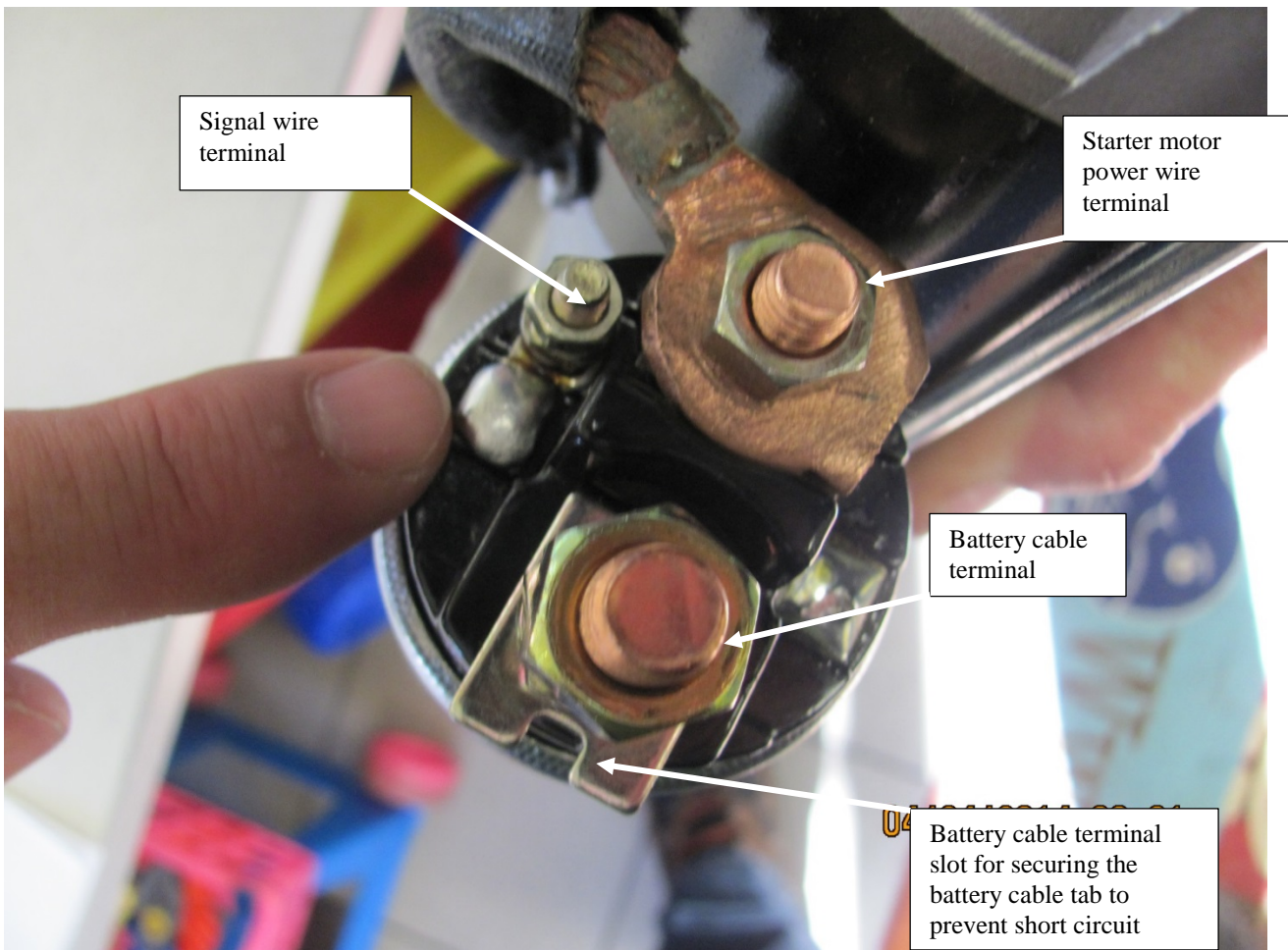


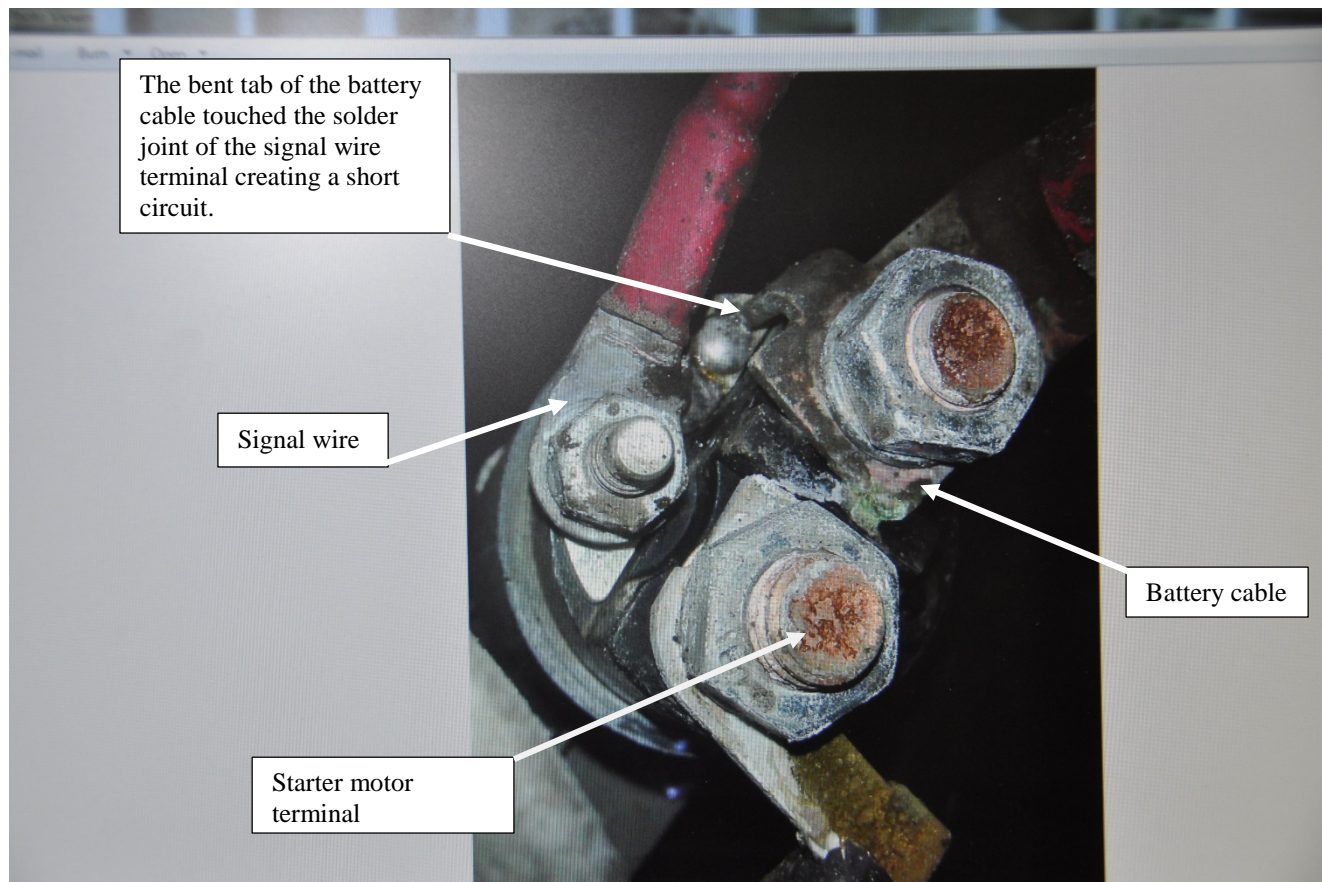
Figure 1. Diagram of a car starting system (Courtesy of Samarins.com)

There are three terminals on the starter solenoid of a Ford 550 Super Duty truck: the battery cable, the signal wire, and the starter motor terminals (Photo 3). The battery cable connects the solenoid to the positive terminal of the battery. The signal wire connects the solenoid with the starter control circuit composed of ignition switch, starter relay, and neutral safety switch. The battery cable should be secured to prevent it from contacting with any part of the signal wire or the starter motor power wire.

Photo 4 shows how the cables were connected to the solenoid of the flatbed truck that was involved in the incident. There was a tab that was bent at a 90 degree angle on the truck's battery cable (Photo 4). In order to prevent a short circuit, the tab should be securely placed into the slot on the battery terminal (see "battery cable terminal slot" in Photo 3). As it is shown in photo 4, the battery cable tab was not placed in the battery cable terminal slot. Instead, it was 90 degrees counterclockwise from its designed position. The bent tab was in close proximity to a raised solder point of the signal wire terminal. The battery cable was not tightened and it could be wiggled by hand. The Ford certified mechanic noticed that the starter motor was hot which indicated that the starter motor was getting power from the battery even when the truck was not running. He concluded that the likely cause of the spontaneous starting of the truck was the short circuit on the solenoid.



*Photo 3. Terminals on a new Ford 550 Super Duty truck solenoid. The battery cable tab should be secured into the slot to prevent it from contacting the other two terminals (photo courtesy of OSHA).*



*Photo 4. Three terminals (battery cable terminal, signal wire terminal, and starter motor power wire terminal) on the Ford 550 Super Duty truck solenoid and the cables connected to them. The tab of the battery cable contacted the solder joint of the signal wire creating a short circuit (photo courtesy of OSHA).*

The starter unit was located under the passenger side door. While the victim was cleaning the passenger side with the pressure washer, the bent tab on the battery cable likely contacted the soldered point on the signal wire terminal. The short circuit sent the battery power to energize the starter motor that caused the truck, which was in First gear, to lurch forward and crush the victim.

The mechanic also found that the neutral safety switch on the truck was broken. A neutral switch is a device for preventing accidental or unintentional starting of a vehicle. It is installed at the automatic transmission shifter mechanism, or at the clutch pedal for manual transmission (Figure 1). A vehicle can only be started when the ignition key is turned to START position and the automatic transmission shifter is in “Park” or “Neutral” position, or when the clutch pedal is depressed if the vehicle has a manual transmission, as in this case. The broken neutral safety switch did not contribute to the spontaneous start of the truck since the starter control circuit including the neutral safety switch was bypassed due to the short circuit on the solenoid.

The auto body shop’s insurance company conducted a forensic examination of the flatbed truck and developed a report. However, the forensic report was not available to the NY FACE investigator due to

litigation. The attorney representing the auto body shop confirmed that the forensic examination did not reveal any manufacturing fault of the truck.

OSHA determined that the hazard in this case could not be recognized by the employer and did not issue a citation.

## **RECOMMENDATIONS/DISCUSSIONS**

**Recommendation #1:** *Employers should ensure that workers always set parking brakes and chock the wheels when working on or around a vehicle.*

**Discussion:** The flatbed truck spontaneously started and moved forward due to an improperly installed starter. To prevent injury, workers should always set the parking brakes and chock the wheels before working on or around a vehicle. Employees should include this requirement in the company safety standard procedure and provide worker training and supervision to ensure compliance.

**Recommendation #2:** *Employers should ensure that employees take extra precautions to insure that starters are installed properly according to the manufacturer's specifications.*

**Discussion:** In this case, the tab of the battery cable was not secured in the slot on the solenoid battery terminal to prevent it from contacting the signal wire. When installing a starter, extra precautions should be taken to ensure that the battery cable is properly installed to prevent a short circuit. Employers should ensure that all parts are installed strictly following the manufacturer's requirement.

**Recommendation #3:** *Emergency response staff should set the parking brake, chock the wheels, and disconnect the main battery cable to prevent movement of a vehicle when responding to a vehicle emergency.*

**Discussion:** The short circuit between the battery cable and the signal wire in this case caused the truck to lurch forward. When responding to a vehicle-related call, emergency response staff should always set parking brake, chock the wheels, and disconnect the battery cable to prevent accidental start or movement of the vehicle. The EMTs in this case did not take these prevention measures.

**Recommendation #4:** *Manufacturers should consider modifying the design of solenoid terminals to prevent a short circuit between the terminals.*

**Discussion:** The three terminals on the Ford 550 Super Duty starter solenoid were in close proximity to each other. Manufacturers should consider modifying the design to prevent the battery cable from contacting the signal wire. An insulation barrier could be installed between the terminals to prevent a short circuit.

**Recommendation #5:** *Manufacturers should warn mechanics in the service manual to strictly follow the installation instructions to avoid short circuits when installing a solenoid.*

**Discussion:** A hazard warning in the service manual may help mechanics recognize the hazards associated with a short circuit on a solenoid. Manufacturers should consider adding a hazard warning in the service manual to alert mechanics about the danger of a short circuit and how to prevent it.



**Recommendation #6:** *Manufacturers should consider installing a neutral safety switch warning light to indicate the failure of the device.*

**Discussion:** A neutral safety switch is a part of the starter control circuit that prevents the accidental start of a vehicle. The neutral safety switch ensures that a vehicle can only be started when the key is turned and the automatic transmission shifter is in “Park” or “Neutral” position, or when the clutch pedal is depressed if the vehicle has a manual transmission. Although the broken neutral switch did not contribute to the spontaneous start of the truck in this case, it did raise a safety concern. The truck driver could not detect the broken neutral safety switch, since he always depressed the clutch pedal whenever he tried to start the truck. The Ford 550 Super Duty truck did not have an indicator light for the failure of the device. Manufacturers should consider installing a warning light to warn drivers of neutral safety switch malfunctions on all vehicles.

**Keywords:** *truck, spontaneous start, truck starts on its own, starter solenoid, electrical short, signal wire*

## REFERENCES

1. Starting system, starter motor. Samarins.com. retrieved August 10, 2015 from <http://www.samarins.com/glossary/starter.html>.

The New York State Fatality Assessment and Control Evaluation (NY FACE) program is funded by the National Institute for Occupational Safety and Health and administered by the New York State Department of Health. NY FACE is a research program designed to study the causes of workplace fatalities and develop practical and effective prevention measures. NY FACE investigators evaluate information from multiple sources and provide recommendations for prevention in summary reports. These recommendations are distributed to employers, workers, and other organizations interested in promoting workplace safety. The NY FACE does not determine fault or legal liability associated with a fatal incident. Names of employers, victims and/or witnesses are not included in written investigative reports or other databases to protect the confidentiality of those who voluntarily participate in the program. Additional information regarding the NY FACE program can be obtained from:

New York State Department of Health FACE Program  
Bureau of Occupational Health and Injury Prevention  
Corning Tower, Room 1325  
Empire State Plaza  
Albany, NY 12237  
866-807-2130  
518-402-7900

[BOH@health.state.ny.us](mailto:BOH@health.state.ny.us)

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