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CLEAR THROUGH TO THE FACTS
AUTOmotive | Forensics

TO David Shapiro
Assistant City Solicitor
City of Somerville
93 Highland Avenue
Somerville, MA 02143

ATTENTION David Shapiro

DATE March 18, 2019

VEHICLE ANALYSIS – SDL# 10744.1

INSURED Somerville DPW
VEHICLE 2017 Ford F550 Super-Duty
VIN 1FDUF5HY1HED35804
ODOMETER Unknown
DATE OF LOSS April 13, 2018

Fire Incident Background

On April 13, 2018, two Department of Public Works employees for the City of Somerville were operating a 2017 Ford F550 Super-Duty, equipped with an aerial bucket in the DPW yard. While cleaning gutters on the roof the DPW building, a fire started in the Ford truck. I interviewed Norman Tennison and Vincent Mitrano, who were both in the bucket of the aerial truck, up on the roof the building when the fire started. Mr. Tennison and Mr. Mitrano said they did not use the Ford aerial lift truck on April 12, 2018, but had used the truck on preceding days. On the morning of the fire, Mr. Tennison and Mr. Mitrano had driven the truck approximately 100' and pulled it up in front of the building at approximately 7:30AM. They had no problems when they started the truck up. They extended the outriggers and both men climbed into the bucket and elevated it up onto the roof where they got out to clean the gutters. They were on the roof approximately 20-30 minutes, and when they were done, they walked back to the bucket of the aerial lift which was elevated just above the roof. Norman Tennison said they left the Ford truck running while they were doing work up on the roof. When they hit the PTO button to lift the bucket off the roof, the boom began to move slightly and then suddenly the PTO button would no longer respond. Norman Tennison said he immediately saw white smoke and then fire under the Ford truck, and then it began to spread to the engine of the truck.

Tony Pantanella is a mechanic in the garage at the DPW. He stated he saw fire at the rear of the engine, but no fire in the cab. He ran over and sprayed a hose on it but he was unable to extinguish the fire. He said he was going to open the hood but he was unable to get near it. Mr. Tennison and Mr. Mitrano got out of the bucket and back onto the roof, and the truck continued to burn until the fire department arrived and extinguished the fire.

Mr. Tennison and Mr. Mitrano said they had some prior problems with the aerial lift truck. They said in late December, 2018, there was a leak and they saw fluid leaking onto the exhaust under the Ford truck, and they saw white smoke coming up from behind the cab. The truck was taken to the city garage and something was done to it. They were able to lower the bucket down and never lost control of the aerial bucket. They indicated the Ford truck had also been taken to CUES, Consolidated Utility Equipment Service, approximately two weeks before the fire occurred on April 13, 2018. Unspecified repairs or service was done at CUES.

Norman Tennison had been employed by the Somerville DPW for four years. He said when the truck was purchased by the department, he was trained by someone from Danvers Ford on how to use the truck. He did not use a manual, but was told while in the truck it should be idling. Mr. Tennison said during the first incident that occurred where they had seen smoke but no fire, the truck was also idling when they were using it.

Vincent Mitrano worked for the DPW for fourteen years. He also stated that training was provided by someone from the Ford dealer on how to use the truck. He said he also watched a video on how to use the truck. He could not remember who the person was that trained him, and he did not see or read an instruction manual. He confirmed that the truck was running when they went up on the roof on the day of the fire. Mr. Mitrano said he was never told to leave the truck idling or not to leave the truck idling during the training. He said the truck was running the entire time they were up on the roof on April 13, 2018. He said that he was never told that if you did something wrong or left the truck running that the truck could catch on fire.

I did not receive repair invoices from CUES or from the Somerville City Garage for any service work or repairs performed on the Ford F550 aerial bucket truck. The 2017 Ford F550 Super-Duty, cab and chassis is equipped with a Stamm aerial bucket. It is a model Signalier ATR 41 N. I obtained a Signalier ATR 41 N specification sheet of the truck's features for review. The aerial lift device is manufactured by Versalift. Stamm Manufacturing is a distributor of the Versalift product. Versalift is owned by Time Manufacturing of Waco, Texas.

I was advised by Mr. Tennis and Mr. Mitrano that the truck had been sent to CUES. CUES is a new and used heavy truck sales, service, and parts dealer, with multiple locations. A review of the CUES website shows they have a number of aerial lift products they sell and service that include brands manufactured by Elliot, Autocrane, UTEM, Niftylift, Fiberline, B&G Industries, and Lift Up. The website does not indicate they are a dealer or distributor for Versalift. The website indicates they are a full-service repair shop for trucks, including aerial bucket trucks.

The City of Somerville Department of Public Works had video surveillance on the DPW property. A video surveillance camera was aimed directly at the driver's side of the 2017 Ford F550 and a portion of the building and the roof. The entire sequence of the fire incident was recorded. A copy of the recording was made available to all interested parties.

Objective

Inspect the 2017 Ford F550 Super-Duty aerial bucket truck. Determine the origin and cause of the fire.

DATE INSPECTED	Initial (non-destructive) April 23, 2018
DATE INSPECTED	Joint (non-destructive) June 23, 2018
DATE INSPECTED	Joint (destructive) October 24, 2018
LOCATION	DPW, 1 Franey Road, Somerville, MA

DETAILED ANALYSIS

Vehicle Equipment

YEAR	2017
MAKE	Ford
MODEL	F550 Super-Duty
BODY	2-door, regular cab
ENGINE	6.8L, Triton V10, gasoline engine
TRANSMISSION	Torqshift 6-speed automatic with all-wheel drive

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Source of Information

- City of Somerville DPW video surveillance recording.
- Witness interviews; Norman Tennison, Vincent Mitrano, and Anthony Pantanella.
- Versalift website.
- Stamm Manufacturing aerial bucket truck model Signalier ATR 41 N specifications.
- Parker/Chelsea power takeoff owner's manual, Ford F-series model 249.
- Chelsea 249 series Ford Super-Duty overview and features.
- CUES website.
- Ford service content, 2017 Ford F550 Super-Duty, Ford Motor Company technician workshop software.
- Inspection of Fire Scene, 2017 Ford F550 Super-Duty.
- Destructive examination of 2017 Ford F550 Super-Duty with Stamm Manufacturing/Versalift aerial bucket.

Analysis of Surveillance Video

A surveillance camera recorded the entire fire incident from a camera that was mounted on a utility pole located to the upper left of the Ford F550. The surveillance camera was mounted above the level of the roof of the building and it was aimed down at the parking lot. The video has a timer that records in hours, minutes, seconds, and tenths of a second. The clock on the video was not in sync with the actual time of day but the clock provides an accurate timeline of events. The surveillance video recorded the inception of the fire that originated under the Ford truck and the development and spread of the fire. The video also shows where the individuals were located and the how the truck was being used at the moment the fire started. I captured 14 still images from the surveillance video that show the Ford truck in use with the aerial bucket elevated above the roof of the building, the entry of the two workers into the bucket, and then the initial motion in an attempt to raise the bucket off the roof of the building in order to ascend back down to the ground.

The first image I selected shows nobody was in the bucket and there was no evidence of any smoke or fire emanating from the Ford truck. The Ford truck engine was running and the caution lights on the truck were flashing. In the next image selected (approximately 4 seconds later), there is nobody in the bucket, however, the first indication of slight smoke can be seen coming out from just below the driver's door. The video recording shows slight smoke coming out from under the cab as the two workers are walking toward the bucket. In the next image selected (approximately 36 seconds later) the two workers are in the bucket. The video shows the bucket boom began to rise up several inches and then stopped suddenly. Simultaneously as the boom began to rise, a puff of smoke can be seen underneath the cab of the truck where it would be orientated to the left side (driver's side) of the transmission. In the next image, 1.5 seconds later, smoke and light can be seen under the left side of the cab, then less than a second later fluid can be seen burning on the ground below the left side of the transmission bellhousing. Seven seconds later there is a pool of fluid burning on the ground under the left side of the transmission.

The workers in the bucket said they activated the PTO and boom began to move and stop suddenly, and then they saw smoke coming from the cab followed by fire. The analysis of the events shown in the video were crucial in determining the cause of the fire after completion of the destructive analysis of the truck during the third inspection. The video shows after the fire was detected, the two workers got out of the bucket and the glow underneath the cab dissipated momentarily. A large puddle can be seen under the left side of the transmission near the bellhousing and the fire was not extinguished at this point in time. Within seconds the fire grew into a bright glow and burning fluid can be seen directly under the left side of the transmission bellhousing. The DPW mechanic can be seen approaching the Ford truck with a hose in his hand. The fire continued to spread underneath the left side of the transmission and more fire extension up the back of the cab. Fire can be seen coming out the cowl and the left front wheelhouse. The fire eventually begins to burn up the side of the rocker panel and driver's door as the mechanic attempts to suppress the fire with a small garden hose. He was unable to control the spread and growth of the fire.

My analysis of the fire inception and fire growth observed in the surveillance video shows transmission fluid was leaking onto the exhaust causing very slight smoking under the cab. When the worker in the aerial bucket activated the PTO switch to move the bucket/boom, the automatic transmission suddenly leaked a substantial amount of transmission fluid from the left side of the transmission onto the left side exhaust and the catalytic converter, which immediately ignited the fluid. The fire development captured by the surveillance video shows there was slight smoke come out from under the cab and then subsequent ignition of transmission fluid occurred simultaneously when the operator in the aerial bucket activated the PTO and the boom of the aerial lift moved up several inches and stopped. The operator said he had no further control of the aerial bucket and it would not operate. The slight motion of the aerial bucket/boom and the sudden loss of the boom control coincided with the sudden burst of transmission fluid that was immediately ignited by the hot surface temperature of the left side exhaust pipes. The observation of the initial fire development was not consistent with the ignition of crankcase oil from the engine or gasoline from the fuel system.

Initial Inspection of Fire Scene (Non-Destructive) April 23, 2018

S. D. Lyons, Inc. was requested to survey the fire scene. I made arrangements to inspect the fire scene on April 23, 2018. Upon my arrival I observed the Somerville Public Works Ford truck parked in front of the public works building. The aerial boom was elevated and the bucket was resting just above the roof. I was advised that the Ford truck had not been moved and nothing had been disturbed since the fire. A blue tarp had been placed over the vehicle and caution tape was wrapped around it. I analyzed the fire patterns appearing on the exterior, within the passenger compartment, and the underside of the truck. Only a non-destructive examination was conducted and nothing was disturbed.

I observed a pool of automatic transmission fluid underneath the truck, with most of the fluid located below the left side (driver's side) of the automatic transmission. The fluid on the ground was red in color and I identified it as transmission fluid. The fluid was not crankcase engine oil, hydraulic oil, or gasoline. I examined and photographed the underside of the truck. I noted transmission fluid dripping from

the transmission crossmember and the exhaust pipe. I noted the fire burned most intensely on the left side of the automatic transmission, adjacent to the left side exhaust pipe. I noted an aftermarket exhaust heat wrapping had been wrapped around the left side exhaust pipe but nowhere else on the exhaust system. It was apparent to me that someone had put the heat wrapping on the exhaust to protect a transmission hose extending from the transmission case to the PTO pump mounted on the left front of the automatic transmission. The exhaust wrapping was limited to the left side exhaust downpipe and the exhaust pipe extending below the lower left side of the automatic transmission. The exhaust heat wrapping was saturated with transmission fluid and it had a burned appearance. The highest loss of mass caused by the fire occurred on the left side of the transmission, in the area of the PTO and hydraulic lines. The PTO was equipped with a cartridge valve and pressure switch which is remotely activated by the operator in the bucket of the aerial lift to engage the PTO remotely. The valve and pressure switch require a pressured line extending from the transmission. I noted the transmission line consisting of a steel braided hose was extensively burned on the left side of the transmission.

I identified the area of origin of the fire was on the left side of the transmission where the PTO and transmission gearshift mechanism are located. I observed an opening through the floor pan extending from the undercarriage and into the cab of the Ford truck where the fire spread up through the opening for the all-wheel drive shift lever. The fire spread into the passenger compartment and up through the center of the dash because of the opening in the floor. The fire began to spread up the back of the engine compartment and it scorched the rear of the compartment, the cowl, and the left front wheelhouse. The fire was contained within the engine compartment because of the closed position of the hood.

The fire patterns showed the area of origin was underneath the left side of the cab of the truck. I developed a working hypothesis that during the operation of the Ford aerial bucket truck, transmission fluid sprayed onto the exhaust, and the hot surface of the exhaust system ignited the fluid. I considered additional working hypotheses which would require further examination and analysis of the truck which would include the potential for a destructive examination.

Joint Inspection (Non-Destructive) June 13, 2018

Interested parties were placed on notice of a joint inspection to take place on June 13, 2018, at 10:00 a.m., at the Department Public Works in Somerville, Massachusetts. All parties in attendance examined and photographed the subject Ford aerial bucket truck. The Ford had not been moved from its original location and nothing on the truck had been disturbed since the fire. The joint inspection was non-destructive in nature and nothing was disturbed during the inspection. The Ford cab and chassis, the Stamm/Versalift aerial equipment, and the existing fire patterns were analyzed. We had the opportunity to speak with DPW employees Norman Tennison, Vincent Mitrano, and Anthony Pantanella. Each of the parties in attendance were able to ask questions of the three witnesses to the event. A plan was devised and proposed to each of the parties in attendance to eventually move the aerial lift off truck the roof of the building and lower the lift down so that the Ford truck could be moved from the fire scene. The Ford truck was examined and photographed in more detail to analyze the fire patterns. The group in attendence also had the opportunity to go into the office at the DPW administrative building and view the video surveillance that captured the entire fire incident. The group was able to play back portions of the video and to analyze the events. The group of attendants were advised that they would each be provided with a copy of the video, which we later received.

I examined the undercarriage of the Ford truck and obtained photographs of a pressured hydraulic steel braided hose that extends from a pressure port on the left side of the automatic transmission and travels forward where it extends around the lower-front of the hydraulic pump and then extends vertically to where the transmission line connects to the integrated cartridge valve and pressure switch on the PTO housing. When the Ford aerial lift truck is in operation there are multiple parameters that must be met that integrates the operation of the aerial bucket with the operation of the gasoline engine and the automatic transmission. The engagement and disengagement of the PTO can be controlled remotely from within the aerial bucket when the operational parameters are met. The integration is partly controlled by the Engine

Control Module (ECM) and the transmission control module. The aftermarket PTO has a clutch that engages and disengages the hydraulic lift. To engage the PTO, the multiple parameters must be met, one of which includes hydraulic line pressure from the transmission to the PTO clutch. This line pressure becomes elevated by activation of the PTO switch from within the bucket or at the turret control panel. It applies battery voltage to the power takeoff circuit to signal the transmission to enter the Stationary Elevated Idle Control mode (SEIC). When the mode is engaged, the engine speed elevates to 1200 rpm and remains at that engine speed. The Chelsea 249 series PTO pump made for the Ford Super-duty incorporates the integrated cartridge valve and pressure switch in the housing. The hydraulic line extending from the test port on the side of the Ford automatic transmission provides continuous transmission fluid pressure to the line when the engine is running. Transmission fluid pressure will increase when the engine speed increases. The pressure in the hydraulic line extending from the transmission test port to the PTO is dead-headed when the integrated control valve and pressure switch are not activated. When the operator in the bucket engages the PTO, the engine speed increases, the transmission pressure increases, and the switch activates the clutch in the PTO that engages the operation of the PTO system so that the bucket and boom will function. When the PTO is released, the pressure switch closes the circuit and the engine idle drops down.

I found that the hydraulic line extending from the test port on the transmission extended forward from the port where it passes directly under the hydraulic PTO pump. The transmission line extending to the pressure switch on the PTO housing extended under the front of the pump and then vertically where it looped around and connected with a fitting on the top of the PTO pump housing. The line was up against the thermal wrapping that someone had applied to the exhaust pipe. The entire line was burned. The close proximity of this transmission that is under continuous pressure any time the engine is running, indicates that someone was concerned about the radiant heat emanating from the exhaust pipe and they tried to remedy the situation by applying the heat wrapping to the exhaust pipe. However, the hydraulic line may have already been damaged by heat exposure before the wrapping had been applied to the pipe. Additionally, the wrapping on the pipe does not prevent heat from radiating from the pipe, it reduces the heat radiating from the pipe. I observed that the fire patterns on and under the truck were consistent with fluid having leaked from the aftermarket transmission line extending from the transmission test port to the hydraulic PTO control switch, and onto the hot surface of the exhaust. As noted during my previous inspections, I observed transmission fluid dripping from the left side of the transmission and the transmission crossmember, and a pool of transmission fluid underneath the left side of the transmission where the video confirms the area of origin of the fire. I also observed the position of the transmission line extending to the PTO control switch on the top of the PTO housing. In addition to being close to the exhaust, the transmission line was also rubbing against the insulation on the bottom of the truck floor. The upper portion of the hydraulic line was extensively burned and only the steel braid remained.

I further developed my working hypothesis based on my observation of transmission fluid under the truck, on the left side of the transmission, on the ground below, and observations I made in the surveillance video. I considered other potential fuels first ignited. The Ford truck is equipped with a 6.8 liter, V10 gasoline engine. The engine is fuel-injected and has a fuel tank mounted behind the rear axle, at the rear of the chassis. The electric fuel pump module is located inside the fuel tank and it is a 2-speed pump that operates on different voltages controlled by the ECM depending on the load. The pump delivers fuel under pressure to the fuel rail on the engine. It is a returnless fuel system and utilizes only one fuel line that extends from the fuel tank to the fuel rail on the engine. I researched the fuel line configuration on the Ford Technician website provided by Ford Motor Company. I also examined the fuel lines on the subject 2017 Ford F550. The Ford has a stainless-steel fuel line that extends from the fuel rail at the left rear of the engine and passes over the top of the automatic transmission housing, and extends toward the tail of the transmission and the 4-wheel drive transfer case. The stainless-steel fuel line then bends toward the left side framerail where it connects to a fitting. From the fitting it utilizes a flexible nylon hose that extends to the fuel pump module. I observed that the fuel line still remained on top of the transmission and it extended beyond the rear of the transmission and then toward the left framerail where it was connected to the flex line. The stainless-steel fuel line was not breached where it passed over the transmission and there was no fire damage at the connection to the flex hose which was located further rearward on the left framerail of the Ford truck. The ignition of a fuel under the Ford truck that was recorded by the video also

is not consistent with the ignition of gasoline vapor and a supply of gasoline from the fuel tank. I eliminated gasoline leaking from the fuel system of the Ford truck as a potential fuel first ignited.

I examined area of origin under the left side of the Ford truck to determine potential sources of ignition. I considered the hot surface temperature of the V10 engine as a potential source of ignition due to its high surface temperature while the engine is running, particularly at high RPM and under load. I considered potential electrical sources of ignition consisting of wiring harnesses extending over the top of the transmission, the left side of the transmission, or along the left framerail. I observed the transmission plug connector and harness were burned on the left side of the transmission; however, these are low-voltage signals that provide commands to the solenoids inside the transmission. The harness is not capable of causing a fire in the manner depicted in the video showing the ignition of fluid under the left side of the transmission. I examined wiring harnesses along the left framerail and found no evidence of electrical activity or any conditions for which the electrical harnesses, connectors, or components could ignite fluid under the left side of the transmission. The conductor insulation was burned off some of the wiring but there were no arc marks or beads on the stranded wires. There was no physical evidence of an electrical fault on the wires located on the left side frame. The area or origin of the fire was not at the frame rail. I eliminated electrical energy as a potential source of ignition.

I further developed my working hypothesis relating to the cause of the fire: While the truck was running, transmission fluid initially leaked onto the exhaust before activation of the PTO from within the bucket, then transmission fluid sprayed from the transmission pressure line during operation of the aerial lift. The transmission line leaked a substantial amount of fluid at the instant the operator in the bucket had activated the PTO. The aerial boom moved several inches and then stopped functioning. When the transmission line extending from the pressure port on the side of the transmission to the control switch on the PTO had ruptured and lost pressure, it immediately shut the function of the aerial lift off due to loss of pressure to the clutch.

The joint inspection was concluded by proposing a plan to move the Ford aerial bucket off the roof of the building and into the garage of the DPW where it could be elevated on a lift and a destructive examination could take place.

Joint Inspection (Non-Destructive) August 21, 2018

A joint inspection took place the Somerville Department of Public Works. The Ford was still in the original position where the fire occurred. During a brief meeting it was determined that not all of the interested parties were in attendance. We had the opportunity to interview Noman Tennison and Vincent Mitrano again. An expert representative for Stamm asked specific questions pertaining to their training of the Ford aerial bucket truck when they were assigned to use the truck. The truck was not further examined that day and the inspection was terminated.

Joint Inspection (Destructive) October 24, 2018

A joint inspection of the Ford aerial bucket truck took place at the Somerville Department of Public Works commencing at 10:00 a.m.. A tow company was hired to move the aerial lift truck off of the roof of the building and to disconnect the hydraulic lines and collapse the aerial boom and retract the stabilizers. The Ford truck was then towed inside the building where it was placed on a heavy-duty truck lift. The parties in attendance were able to photograph and examine the truck on the lift.

The truck was raised up on the lift where the entire underside was exposed. The underside of the truck was photographed from various angles at the front, the midsection, and the rear. There were distinct high intensity fire patterns that consisted of a high mass loss immediately to the left of the transmission. The left side exhaust pipe was wrapped with heat tape and various hose clamps were used to hold the tape on the pipe. We noted the relationship of the steel braided transmission pressure line extending from the

left side of the transmission housing to where the line extended up the front of the PTO pump and connected to the integrated pressure switch. As previously noted, the exhaust pipe, the heat wrap, and the transmission pressure line were in close proximity and were nearly touching. I cannot determine when the wrapping had been put onto the exhaust pipe. I was told by the witnesses the Ford aerial bucket truck was brought to CUES approximately 2 weeks before the fire. I did not receive a copy of the service record for repairs done at that time. I cannot determine who put the heat tape on the exhaust pipe or when the heat tape was put on the exhaust. It is obvious the tape was put on the exhaust pipe in order to protect the transmission pressure line extending from the transmission test port to the PTO activation switch. As noted, the transmission pressure line may have been partially damaged by heat exposure before the heat tape was applied to the exhaust.

The group in attendance fully examined the underside of the truck and then decided to unbolt the exhaust pipes from the exhaust manifolds of the V10 gasoline engine and then lower the pipes onto the floor. The pipes were unbolted and lowered to the floor where they could be examined and photographed. After removal of the exhaust components, the PTO pump, the hydraulic fluid lines, and the transmission pressure line were exposed. It was noted that the pressure hose from the transmission test port to the PTO was fractured at the upper fitting where the hose is swaged onto the fitting threaded into the pressure switch. The hose apparently moved slightly during removal of the exhaust pipe and it detached or it was already fractured. The aftermarket transmission hose was also found to be stuck onto a portion of the automatic transmission shift cable housing which is covered in plastic. We unthreaded the transmission hose from the test port fitting on the side of the transmission and lowered the hose down from the side along with a piece of the transmission shift cable. We photographed the hose and then separated it from the transmission shift cable. The aftermarket transmission hose was very brittle and it was carefully placed into an evidence bag and then into a box. We then proceeded to unbolt and remove the Chelsea 249 series pump from the side of the automatic transmission. The electrical connection to the switch was burned and already detached. The rear housing of the PTO pump was unbolted and the hydraulic reservoir line and the high-pressure line were removed along with the housing and also placed into an evidence container. The evidence was placed into plastic bags and put into a box. Several boxes of evidence were returned to the office of S. D. Lyons, Inc. for storage.

Upon removal of the exhaust and the PTO components, the fire patterns were more visible and they confirmed, in addition to the video, the area of origin of the fire as being on the left side of the transmission. The gasoline fuel line could also be seen above the transmission. It was a solid metal line where it passed through the area of origin of the fire. I further examined and photographed wires in the left side of the frame channel. Wires within the harnesses still had insulation on them and there was no evidence of electrical activity.

Upon completion of the destructive examination of the Ford F550 aerial bucket truck, I selected a final hypothesis as to the cause of the fire. The Ford had some previous issues, as recently as two weeks before the fire. Previously, some white smoke had been seen coming up from behind the cab and there was indication of a hydraulic leak. The truck had some repair done in the DPW garage in December 2017, and reportedly was sent to CUES for some unspecified repairs in April 2018, approximately 2 weeks before the fire.

SUMARY:

The truck was in use when the fire occurred. The engine was idling. Two workers had elevated the aerial bucket and climbed onto the roof. The truck had been left idling for approximately 25-45 minutes while the workers cleaned gutters. A detection of slight smoke can be seen under the cab as the workers returned to the bucket and both got into the bucket, closed the door, and activated the PTO. The boom moved several inches up and stopped suddenly. Simultaneously, at the instant the boom moved upward several inches, a puff of smoke can be seen underneath the left side of the cab and it was immediately followed by the ignition of transmission fluid under the left side of the cab. Through my multiple examinations of the subject Ford, I concluded that source of the transmission fluid leak was a rupture in the transmission line extending from the transmission case to the PTO activation switch, which is under

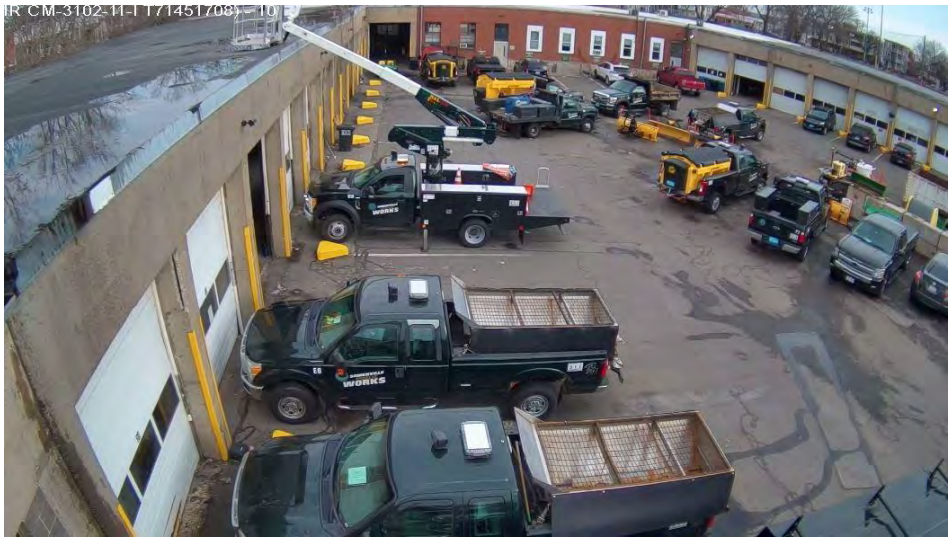
continuous pressure while the truck is running. When the worker activated the PTO, it raised the engine speed and the pressure in the transmission line at which time the transmission line immediately ruptured and sprayed transmission fluid onto the hot surface of the exhaust on the left side of the engine, which immediately ignited the fluid. The fire was burning under the left side of the cab, which was spread by burning transmission fluid. At the same time, transmission fluid was puddling under the left side of the transmission and burning at the ground level. As previously noted, someone had attempted to correct a problem by wrapping heat tape on the exhaust pipe. This was an inadequate repair and the location of the transmission pressure line extending under the PTO pump and up against the exhaust pipe was a flawed design. The pressure line could have run in any route regardless of its length where it would stay free and clear from the exhaust or any heat generated from the exhaust system. The line could have been installed where it passed over the top and connected with the PTO pressure switch. If installed correctly, the transmission line would not have been degraded and would not have ruptured during operation of the truck. Furthermore, it would not have been necessary to wrap the exhaust pipe with heat tape if the transmission pressure line were installed in a different manner.

I concluded the point of origin of the fire was at the left front of the transmission, the source of ignition was combustion heat in the exhaust system of the running truck, and the fuel first ignited was transmission fluid from a leaking and ruptured aftermarket transmission pressure line. The circumstances that brought the fuel and ignition sources together consisted of a poor design which allowed the pressurized transmission line to pass in close proximity to exhaust that resulted in a leak.

S. D. Lyons, Inc., reserves the right to review any additional information, evidence, etc., if such becomes available, and to amend this report and its findings, should it be necessary.

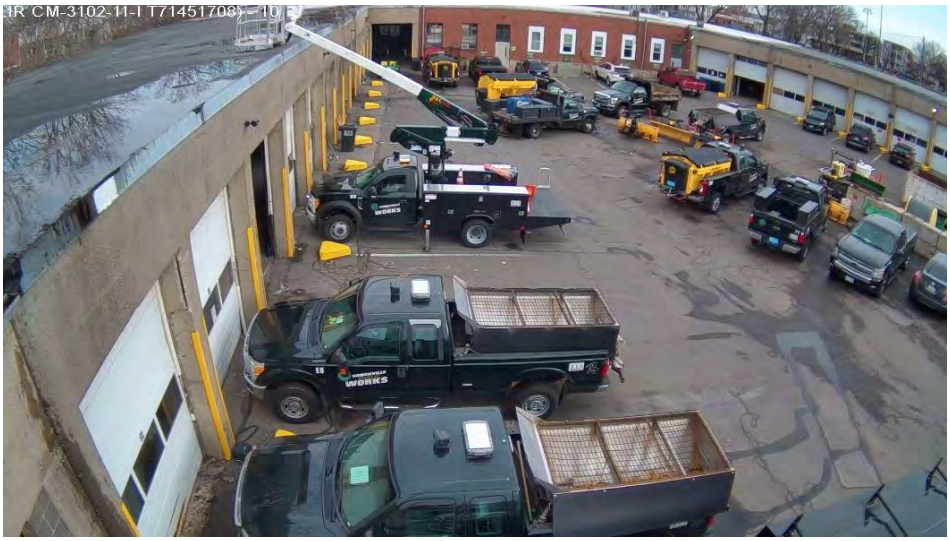
1 Surveillance Video

View of a surveillance camera mounted on a utility pole at the Somerville DPW. It shows the 2017 Ford F550 truck equipped with a Stamm/Versalift in operation. At this point in time the truck engine is idling and the aerial bucket is resting just above the roof of the DPW building. There is no smoke visible under the truck. The workers are not visible at this time and they were in the process of cleaning gutters for approximately 25-45 minutes.



2

Another view of the Ford truck 4 seconds after the previous image. Slight smoke can be seen coming out from under the driver's side of the cab.

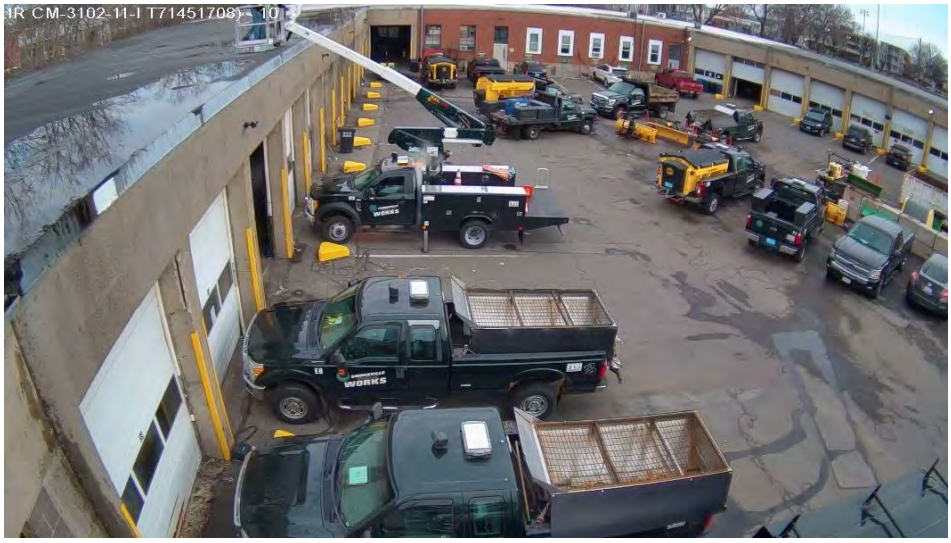


3

The video shows the workers walking back to the Versalift and getting into the bucket. While walking back, slight smoke was detected. They close the door and one of the workers activates the PTO. The video shows the aerial boom lifted several inches and the front of the Ford truck pitched down at the same time due to the weight suspended above and forward of the truck. Simultaneously, when the aerial boom moved, a larger puff of smoke can be seen underneath the truck in this image captured from the video.

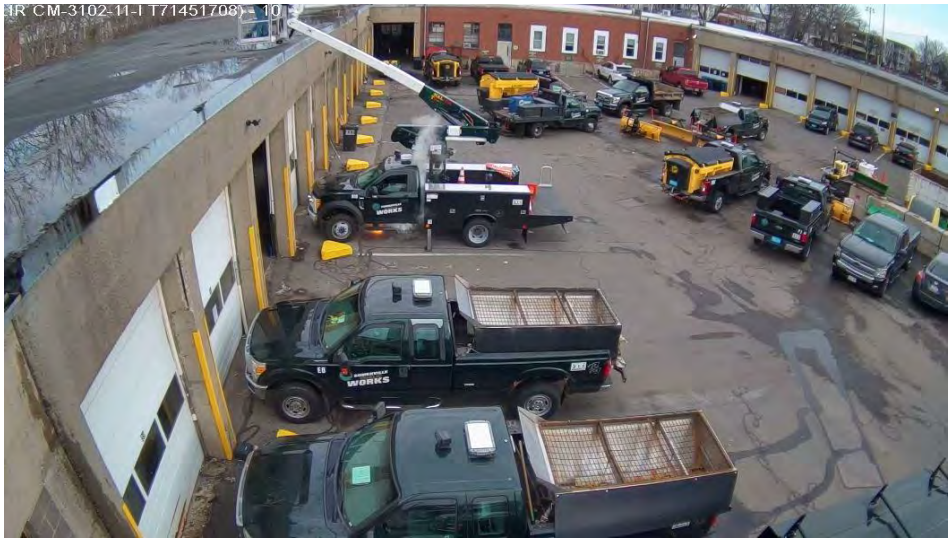
4

A second later after activation of the PTO, more smoke and a glow can be seen underneath the truck and fire coming up the back of the cab. The workers are still in the bucket.



5

1.5 seconds later fire can be seen on the ground and smoke coming up from behind the cab. The fire on the ground is located just below the left side of the bellhousing on the transmission.



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More fire can be seen on the ground below the left side of the transmission, and the workers are still in the bucket.

7

View of more intense fire on the ground under the left side of the transmission and coming up from behind the cab. Workers are still in the bucket.

8

A pool of fluid can be seen burning on the ground below the cab and there is fire extension in the left front wheelhouse. The workers are still in the bucket.

9

The workers are out of the bucket. A pool of fluid can be seen under the left front of the transmission, under the cab.

10

Seconds later the fluid is burning again and the puddle is larger. The mechanic can be seen in front of one of the garage doors, dragging a hose.

11

View of the fire spread underneath the cab of the truck and up the back of the cab. The mechanic is standing in front of a pickup truck with the hose.

12

View of intense fire underneath the left side of the transmission and fire up the back of the cab. Fire can be seen at the back of the engine compartment. The mechanic was spraying water on the fire but it would not suppress it.

13

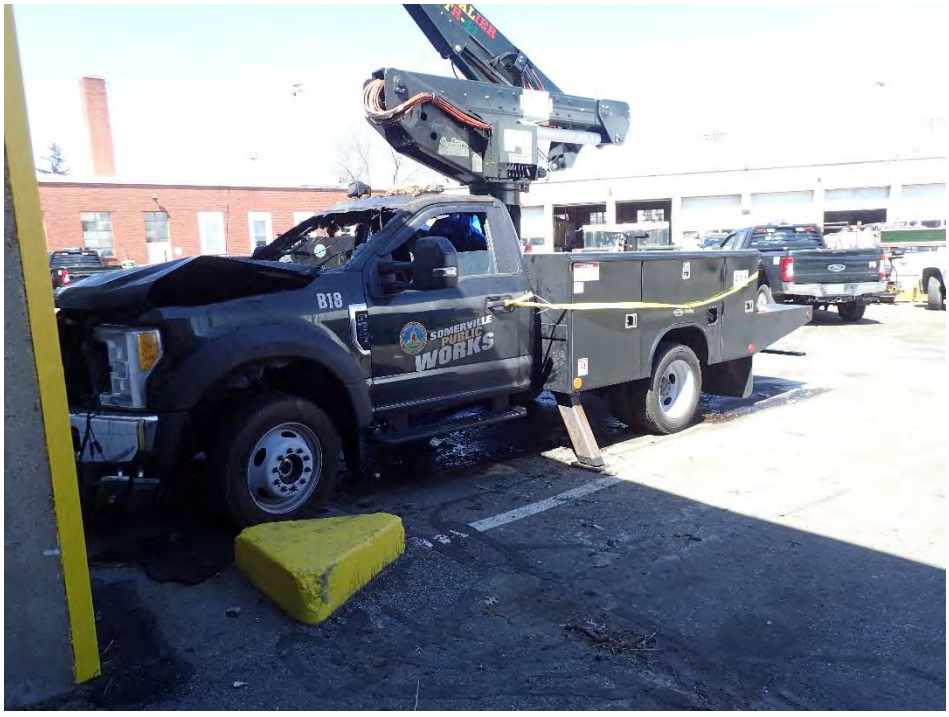
The fire then spreads on the ground underneath the cab and begins to extend up the rocker panel and up the side of the driver's door. There is a large pool of fire burning on the surface of the parking lot.

14

The pool of fire on the ground under the cab is larger and the fire is spreading into the engine compartment. Eventually the fire spreads up through the hole in the floor for the 4 WD shifter and the fire extends into the cab.

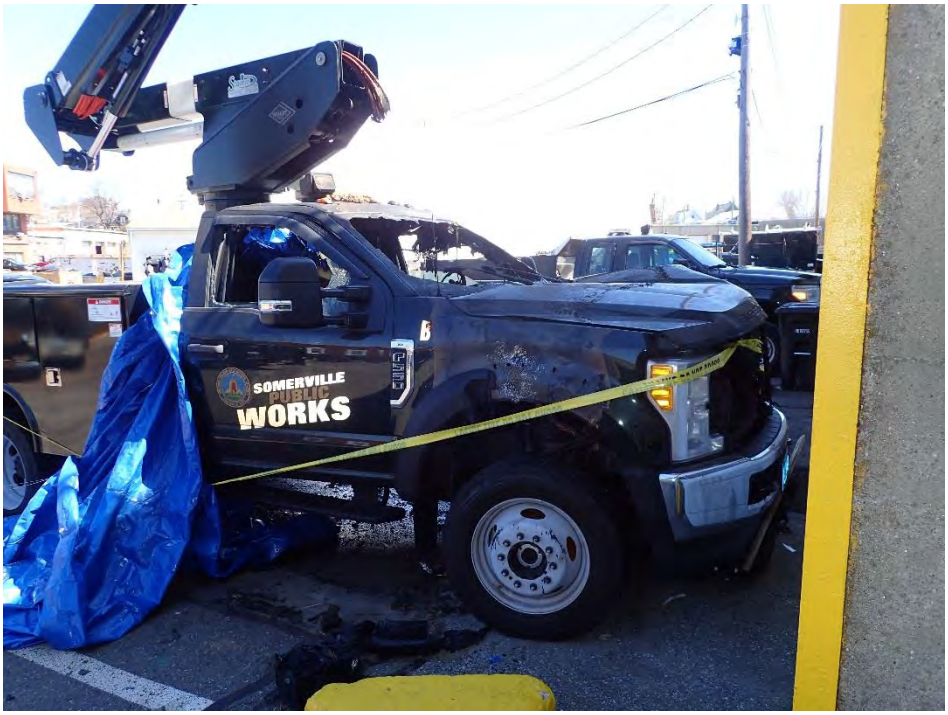
15 Inspection April 23, 2018

View of the 2017 Ford F550 aerial lift truck when it was first examined on April 23, 2018.



16

Right front view of the Ford truck. The truck had not been moved. There was a large puddle of fluid under the cab.



17

View of the aerial lift extending up to the roof.

18

View of the passenger compartment. The fire extended up through a hole in the floor where the 4-wheel drive gearshift selector had been located. The shifter opening in the floor allowed the fire to vent up into the cabin then spread through the dash assembly and out through the windshield.

19

View of fire patterns on the hood and fender.

20

The fire spread throughout the engine compartment. The fire did not originate in the engine compartment.

21

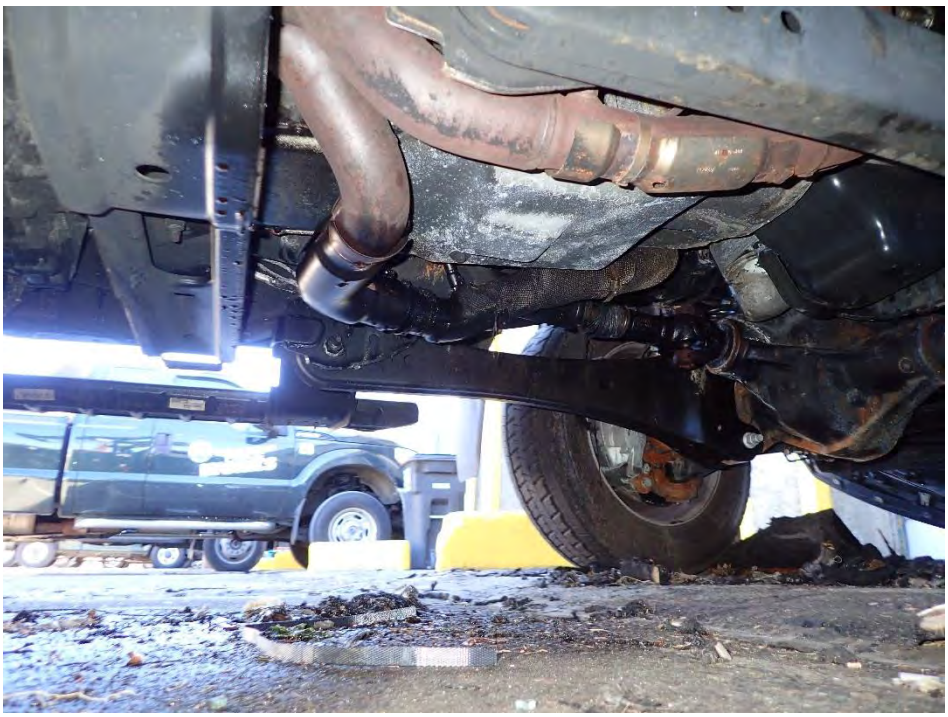
View of the underside of the automatic transmission and exhaust pipes looking from the front toward the rear. The left side (driver's side) exhaust pipe had been wrapped with heat tape. The exhaust pipe, the tape, and the crossmembers were dipping wet with transmission fluid.

22

Closer view of the underside of the engine and transmission. Only the left side was burned.

23

View of the underside of the transmission as seen from the right side (passenger side). Transmission fluid can be seen dripping off the exhaust pipes and transmission crossmember, and a puddle of it is on the ground below.



24

View of the underside of the transmission from the left side. The exhaust pipe heat wrapping was saturated with transmission fluid.

25

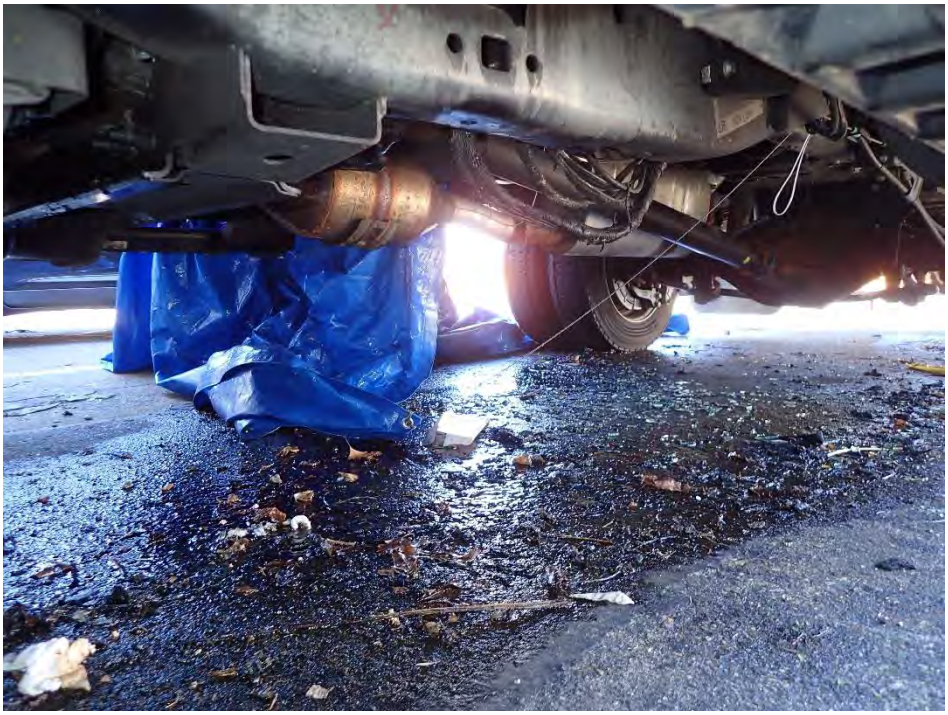
Another view showing the left side of the transmission and the transmission crossmember. Transmission fluid was dripping from the pipe and the crossmember.

26

View of the exhaust system located rearward of the transmission and the 4-wheel drive transfer case. There was no fluid present and this area was not burned..

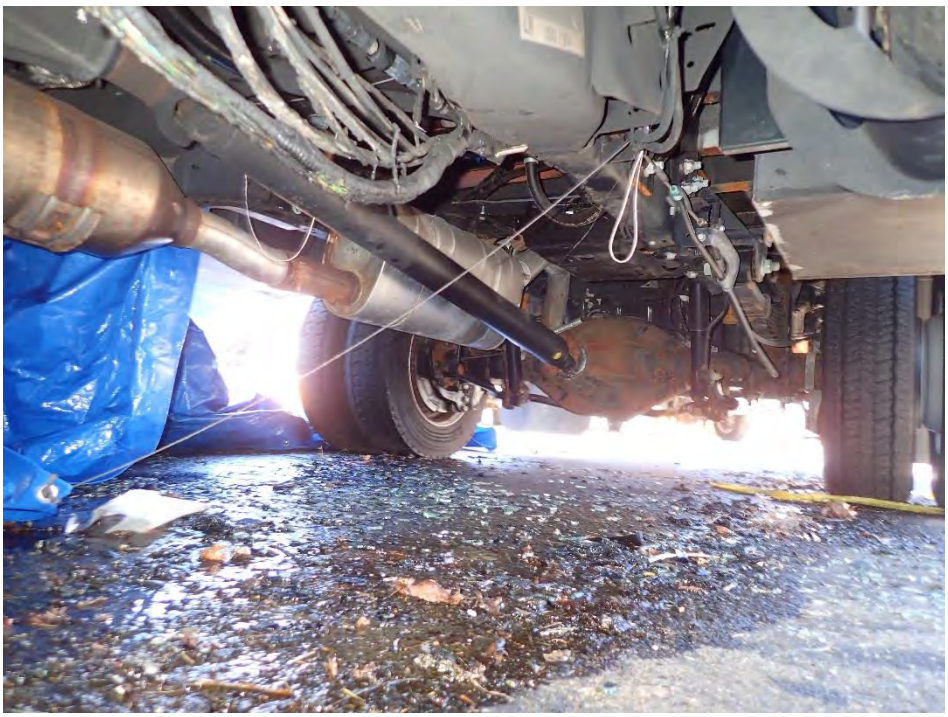
27

View of a puddle of transmission fluid underneath the truck.



28

View looking toward the rear of the truck. There was no fluid extending beyond the transmission. Fluid had dripped to the ground during the fire.

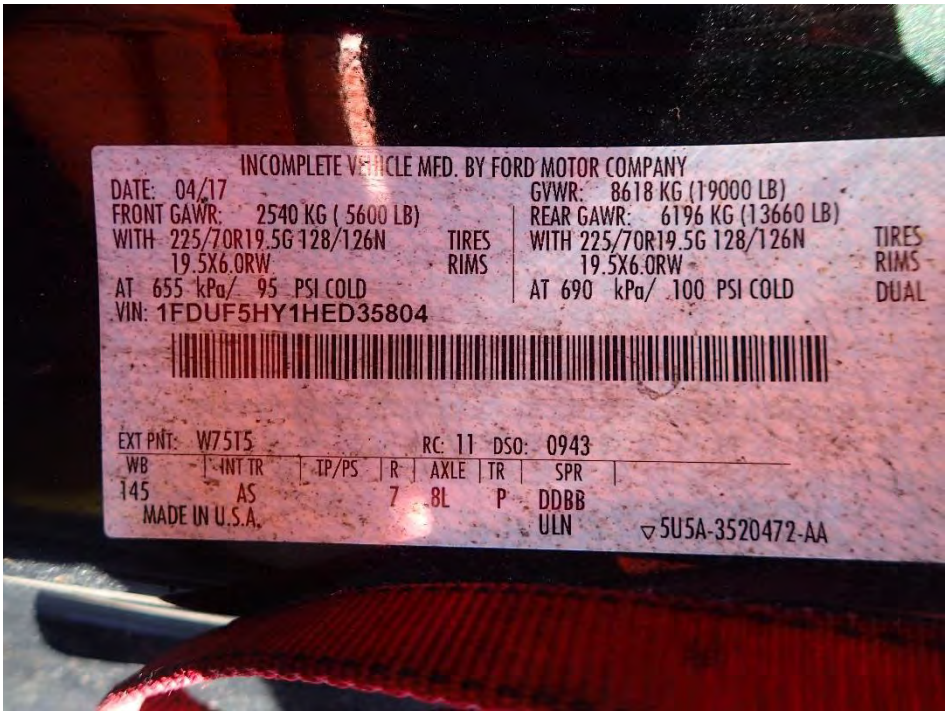


29

Another view of the puddle of fluid underneath the truck.

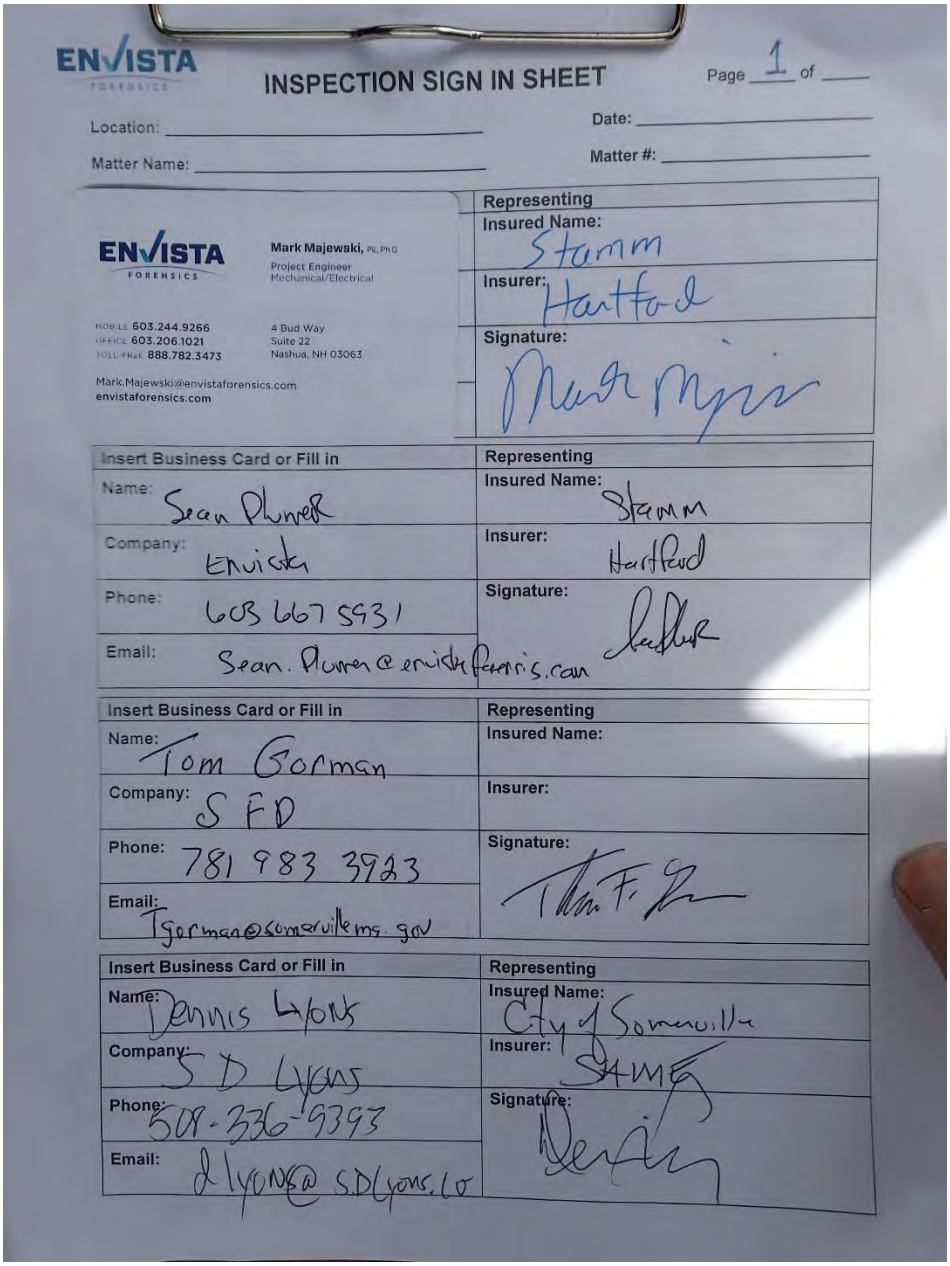
30

View of the VIN.



31 Joint Inspection June 13, 2018

View of the inspection sign-in sheet. Only a non-destructive examination was conducted.



ENVISTA FORENSICS

INSPECTION SIGN IN SHEET

Page 1 of ____

Location: _____ Date: _____

Matter Name: _____ Matter #: _____

ENVISTA FORENSICS

Mark Majewski, PE, Ph.D
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Representing	
Insured Name:	Stamm
Insurer:	Hartford
Signature:	

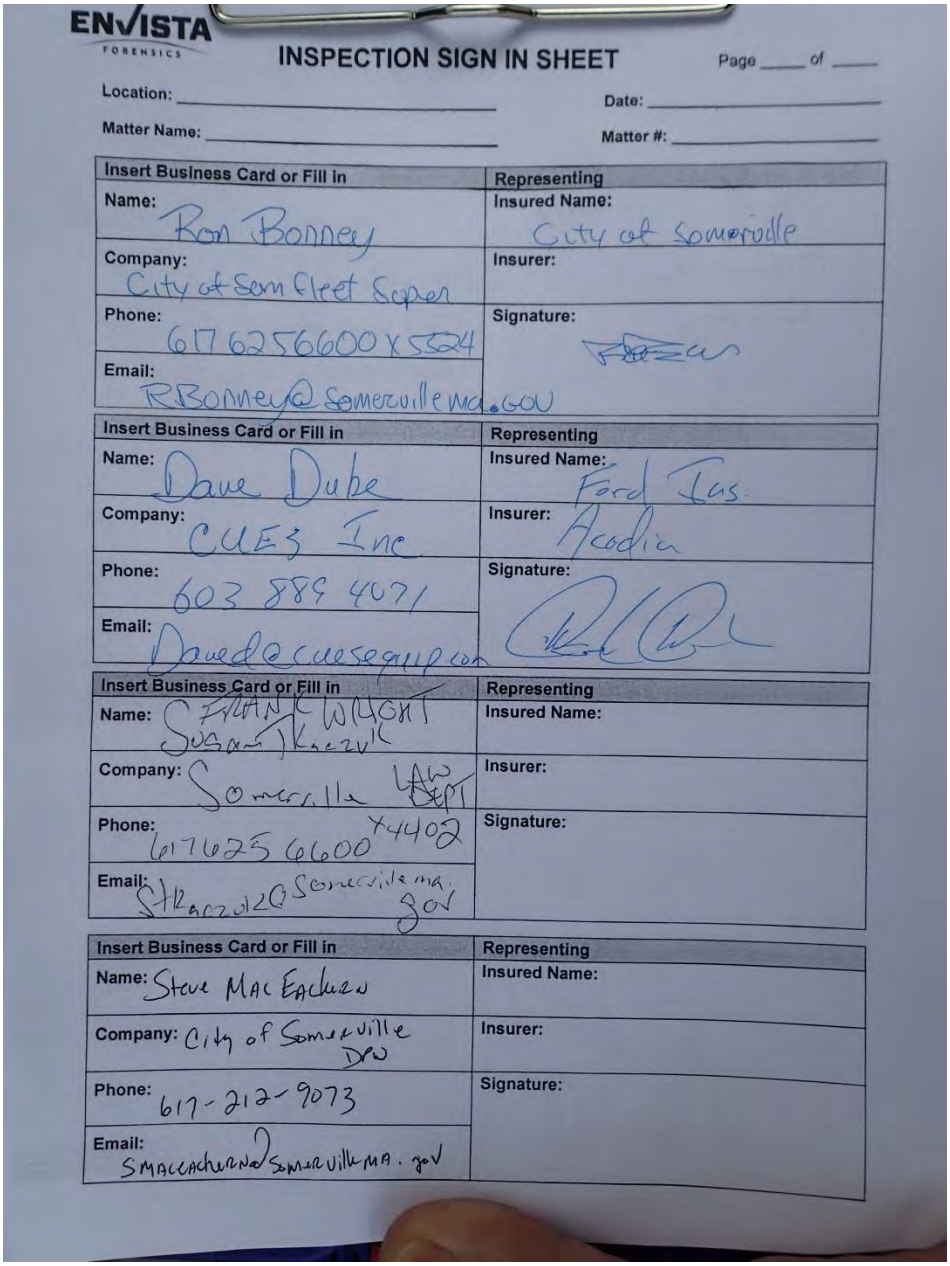
Insert Business Card or Fill in	Representing	
Name:	Sean Plunkett	Insured Name: Stamm
Company:	Envista	Insurer: Hartford
Phone:	603 667 5931	Signature:
Email:	Sean.Plunkett@envistaforensics.com	

Insert Business Card or Fill in	Representing	
Name:	Tom Gorman	Insured Name:
Company:	SFD	Insurer:
Phone:	781 983 3923	Signature:
Email:	Tgorman@somervillema.gov	

Insert Business Card or Fill in	Representing	
Name:	Dennis Lyons	Insured Name: City of Somerville
Company:	S D Lyons	Insurer: SAMS
Phone:	508-336-9393	Signature:
Email:	dlyons@SDLyons.co	

32

Another view of the sign-in sheet.



ENVISTA FORENSICS

INSPECTION SIGN IN SHEET

Page ____ of ____

Location: _____ Date: _____

Matter Name: _____ Matter #: _____

Insert Business Card or Fill in	Representing
Name: Ron Bonney	Insured Name: City of Somerville
Company: City of Som Fleet Super	Insurer:
Phone: 617 625 6600 x 5524	Signature:
Email: RBonney@SomervilleMA.GOV	

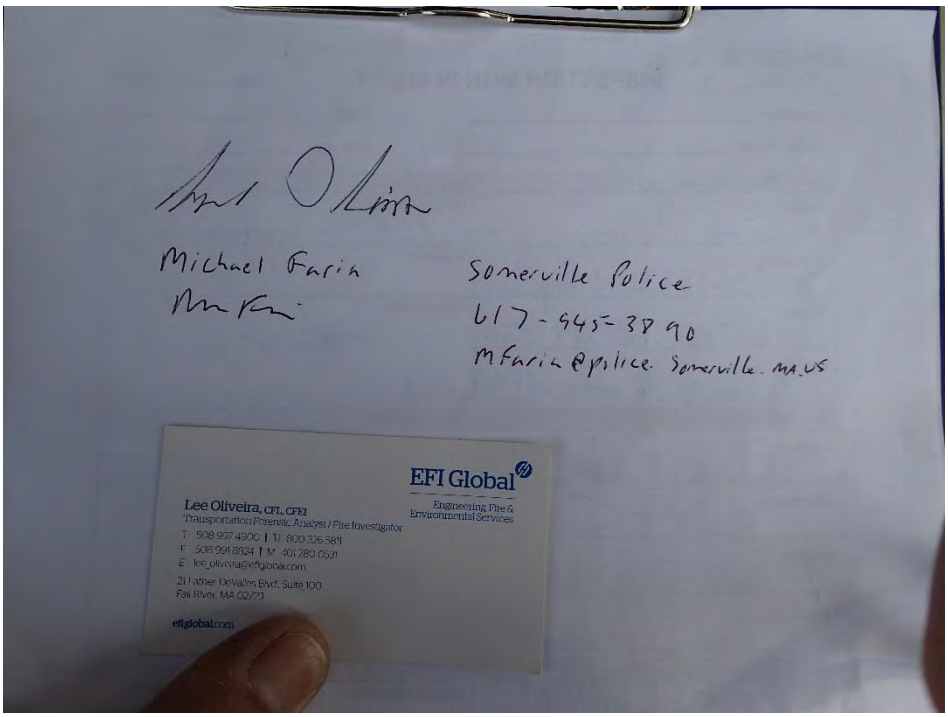
Insert Business Card or Fill in	Representing
Name: Dave Dube	Insured Name: Ford Fcs.
Company: CUES Inc	Insurer: Acadia
Phone: 603 889 4071	Signature:
Email: Dave@cuesequip.com	

Insert Business Card or Fill in	Representing
Name: FRANK WRIGHT Susan Kazol	Insured Name:
Company: Somerville LAW DEPT	Insurer:
Phone: 617 625 6600 x4402	Signature:
Email: SKazol2@Somervillema.gov	

Insert Business Card or Fill in	Representing
Name: Steve MacEachern	Insured Name:
Company: City of Somerville DPW	Insurer:
Phone: 617-212-9073	Signature:
Email: SMacEachern@SomervilleMA.gov	

33

Another view of the sign-in sheet.



34

Left side view of the Ford aerial bucket truck. The truck remained in the same position as the original inspection.

35

View of fire patterns at the left front. The fire extended into the left front wheelhouse area and the grille area at a later stage of development.

36

View of fire patterns at the right front. The fire also vented out the right side wheelhouse and scorched only the rear of the hood.

37

Overview of fire patterns on the right side. There was no scorching to the running board or passenger door.

38

Fire did not extend to the aerial lift device.

39

Left rear view. The platform was not burned.

40

The hydraulic fluid reservoir is contained within the turret.

41

View of the control levers on the turret that allow operation of the aerial lift from the platform of the truck.

42

View of the reservoir and hydraulic filter. Nothing was burned in the turret.

43

View of operating instructions and labels on the turret.

44

Overview of fire patterns on the cab and hood. The fire did not originate in the dash assembly or the cab. Fire patterns on the hood show the fire extended from underneath the left side of the cab and into the rear of the engine compartment.

45

View of the loss of mass at the center of the dash. This occurred from when the fire progressed from underneath the truck up through the opening in the floor for the 4-wheel drive shifter and then into the dash assembly.

46

View of the left side of the cab. Much of the upholstery still remained intact. The fire spread to the passenger compartment at a later stage.

47

View of the dash assembly. The truck has aftermarket components for the Stamm/Versalift aerial bucket equipment.

48

View of the opening in the left side of the transmission tunnel. The fire spread up through the opening and into the passenger compartment.

49

The fire extended up through the opening in the floor and traveled through the center of the dash where it breached the windshield.

50

View of the underside of the engine and the front axle. The engine and the front axle were not burned. The paper label still remained on the axle tube.

51

Another view showing the underside of the V10 engine and the front axle assembly. Nothing under the engine, including the hoses had been burned. The axle assembly was not damaged by heat.

52

View of the left rear of the V10 gasoline engine. The oil pan was not burned and the oil filter and cooler lines remained intact. The fire did not spread underneath the engine.

53

Closer view of the lower left side of the engine. There was no radiant heat exposure to the engine. There was no evidence of gasoline leaking from the rear of the engine.

54

View of the underside of the hood. The aluminum hood began to melt above the left rear of the engine compartment as the fire progressed from underneath the cab and into the rear of the engine compartment at a later stage.

55

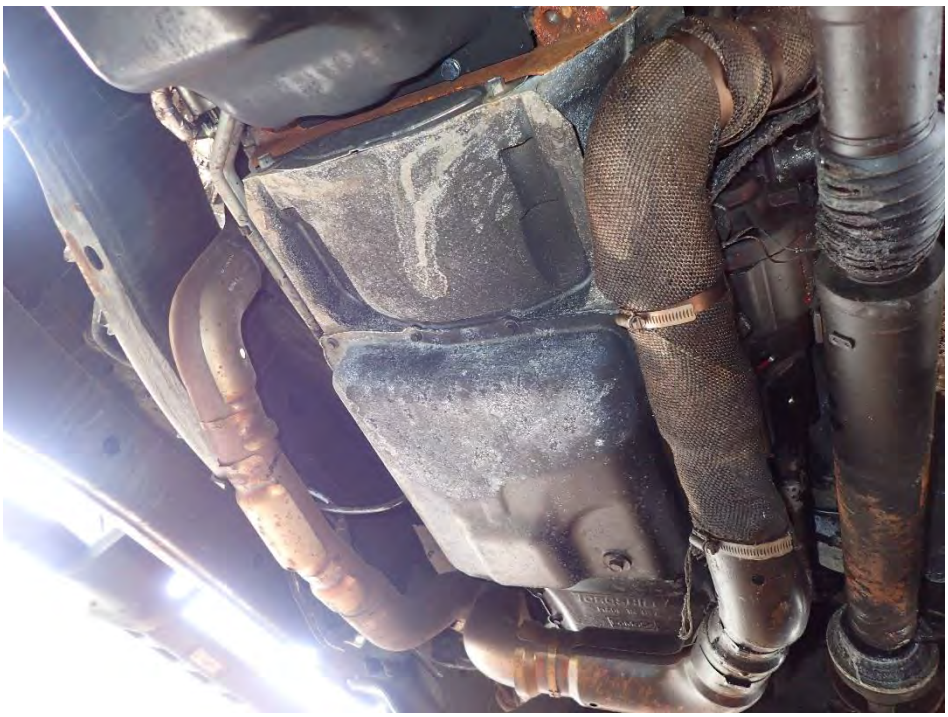
Everything located in the upper region of the engine compartment was damaged by heat contained underneath the hood.

56

View of the left rear of the engine compartment. The aluminum brake master cylinder was intact but the plastic fluid reservoir was partially consumed.

57

View of the underside of the automatic transmission as seen from the driver's side. The exhaust pipe had been wrapped with heat tape that was secured to the pipe using hose clamps. The exhaust pipe and surrounding area were wet with transmission fluid.



58

Closer view of the left side (driver's side) exhaust pipe where it extends down from the exhaust manifold and passes underneath the aftermarket PTO on the transmission.

59

Closer view of the left side exhaust pipe. The PTO can be seen above the exhaust pipe.

60

Closer view of the left side exhaust pipe. The PTO pump is located just above the heat wrap.

61

View of the PTO pump where it is bolted to the side of the transmission, near the bellhousing. The reservoir line can be seen at the back of the pump.

62

View of the left side pipe and the exhaust crossover located behind the transmission. Only the left side of the transmission and the left side exhaust pipe were wet with fluid and burned.

63

The bottom of the photograph shows the exhaust components. Directly above, the shift cable can be seen. The fire vented up through the 4 WD shifter opening in the floor, above the shift cable. The hydraulic PTO pump can be seen on the left side of the photo.

64

View of the automatic gearshift cable and the bracket at the rear of the transmission. The transmission wiring harness and connector can be seen just above the shift cable.

65

View of the PTO pump. The floor pan above the PTO pump was burned. The PTO integrated cartridge valve and pressure switch can be seen on the PTO housing. The transmission pressure line is located just above.

66

View of the pressure switch and the transmission line. The transmission line was rubbing against the bottom of the floor of the truck. The transmission moves independently of the floor of the truck when the engine is running.

67

View of the transmission line where it connects to the integrated cartridge valve and pressure switch that controls the engagement of the PTO. This line is pressurized at all times when the engine is running.

68

Closer view of the pressurized control switch for the PTO and the burned transmission line. As noted, there is continuous fluid pressure in this line when the engine is running. The transmission pressure and the engine RPM elevate when the PTO is activated by the remote control in the bucket. The line was rubbing against the floor of the truck.

69

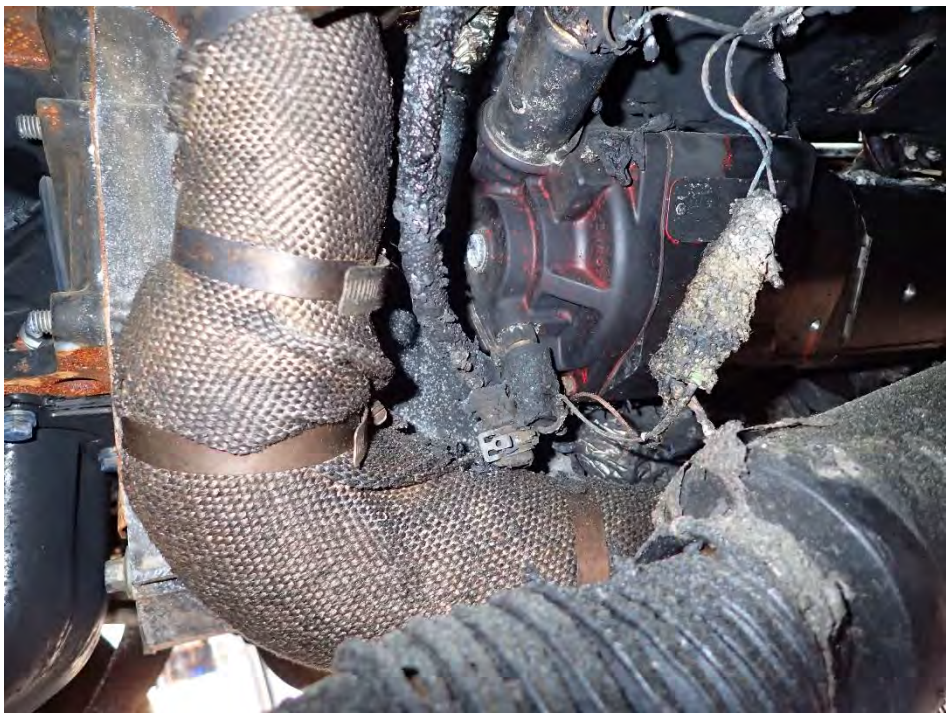
View of the transmission pressure line extending from the transmission test port to the activation valve. The transmission line was up against the exhaust pipe which had been wrapped with heat tape.

70

Another view showing the transmission line near the exhaust pipe. This transmission line may have been damaged prior to the installation of the exhaust heat wrapping.

71

View showing the front of the PTO pump along with the activation switch. Note the position of the hydraulic transmission line in close proximity to the exhaust pipe.



72

Another view showing the exhaust pipe and the transmission pressure line. This transmission pressure line could have been run in a different location where it would not be in close proximity to the exhaust pipe.

73

Close view of the exhaust pipe and transmission line. As noted, this transmission line is pressurized at all times when the engine is running. The engine RPM and the pressure increase when the operator in the bucket operates the PTO.

74

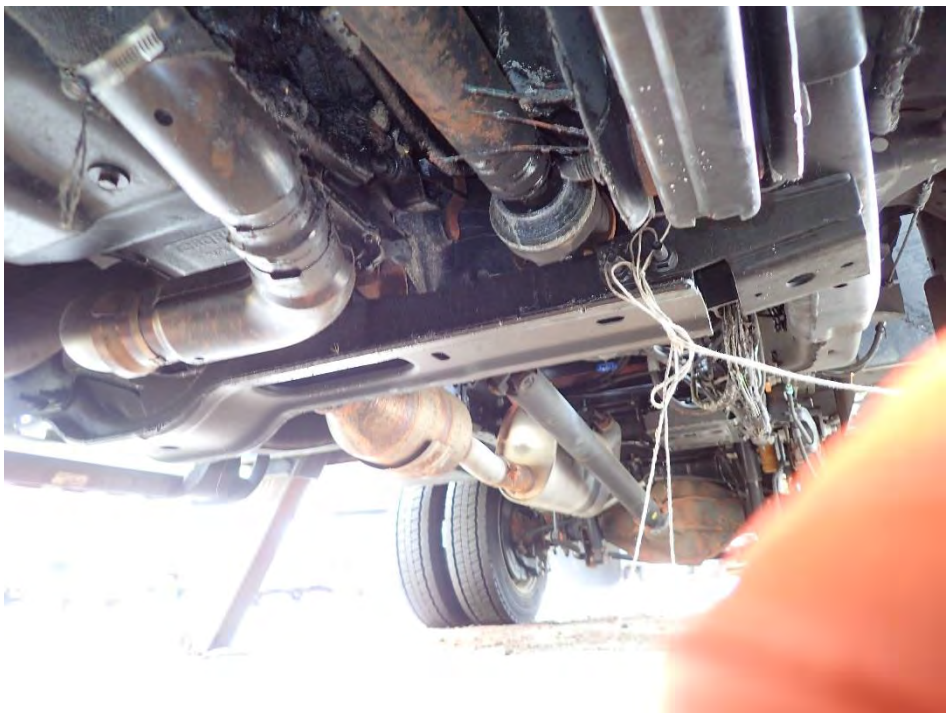
View of the test port on the side of the automatic transmission. The PTO used pressure from this port to provide hydraulic transmission fluid pressure to the activation switch of the PTO.

75

Closer view of the transmission line where it was inserted into the pressure test port on the transmission. This is an aftermarket installation and not installed by Ford during the manufacturing of the truck.

76

View looking toward the rear of the truck. The fire damaged area was on the left side of the transmission only.



77 Joint Inspection October 24, 2018

Some heavy-duty towing equipment was used to remove the aerial bucket off the roof and to disconnect the hydraulic lines, then retract the hydraulic equipment so the truck could be moved.

78

The truck was pulled back in order to lower down the boom and retract the stabilizers.

79

View of the pavement underneath the truck. The fire occurred in April 2018 and the photograph was taken in October 2018.

80

Another view of fluid stains on the pavement underneath the truck.

81

The truck was placed on a truck lift inside the DPW building for inspection purposes.

82

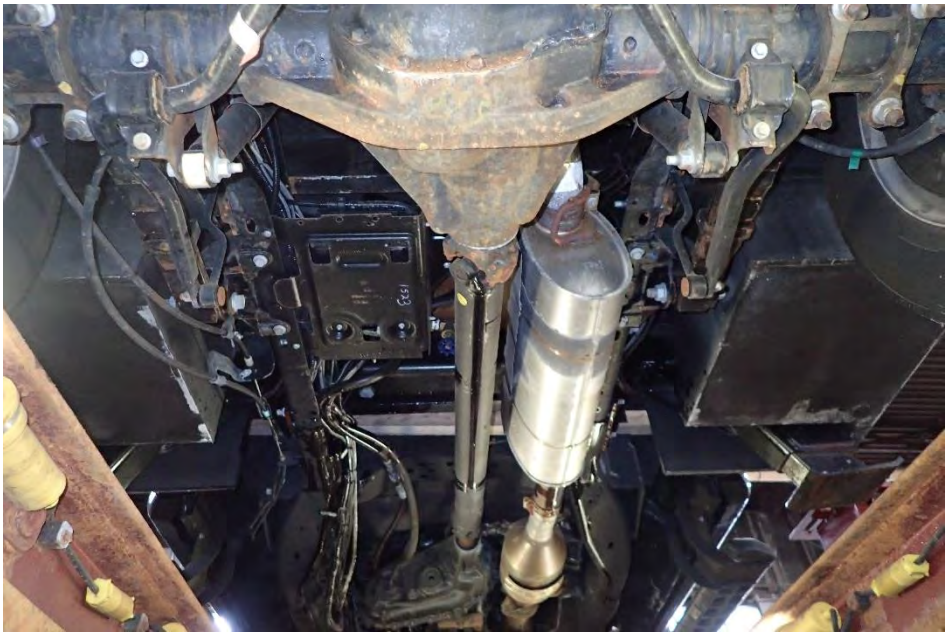
Right front view.

83

Overview of the rear of the truck chassis. The truck is equipped with a rear-mounted fuel tank and it uses an electric in-tank fuel pump module. The system uses a single delivery fuel line.

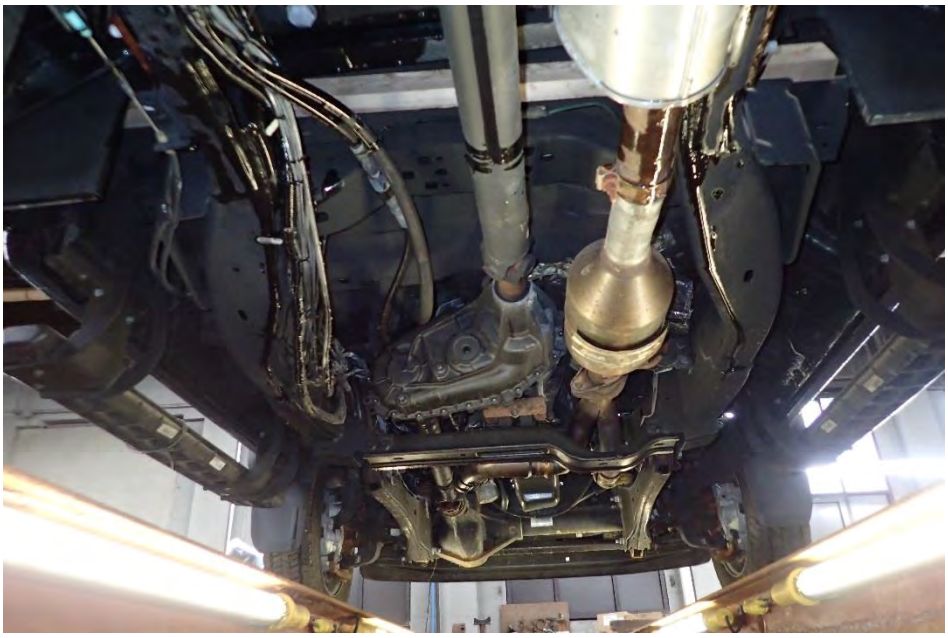
84

View of the underside of the differential and the underside of the Versalift platform. The hydraulic outriggers can be seen on each side.



85

View looking toward the rear of the 4-wheel drive transfer case and the automatic transmission. The fire burned most intensely on the left side of the transmission, forward of the transfer case.

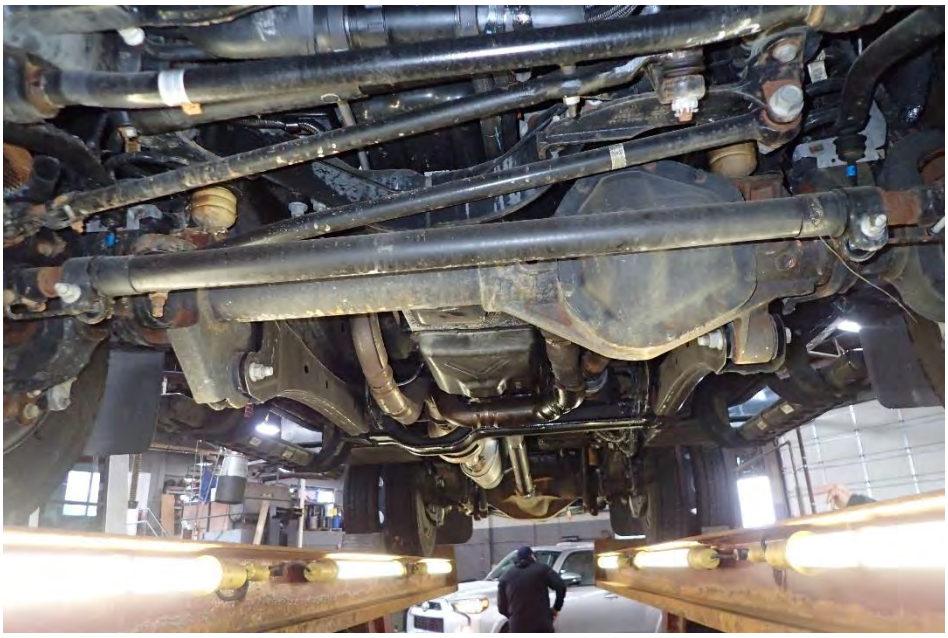


86

View of the front undercarriage. Nothing was burned.

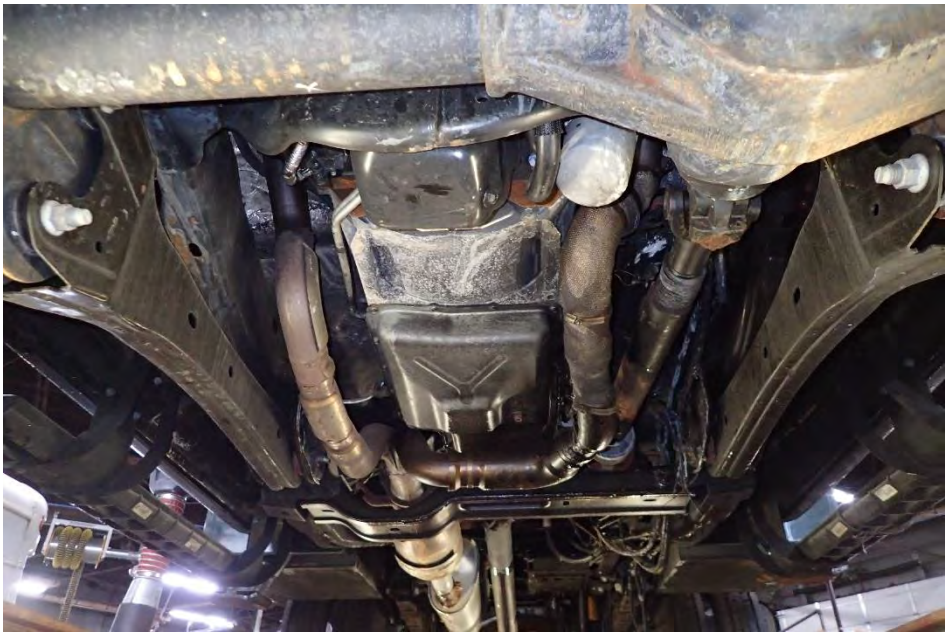
87

View of the front suspension. The fire did not extend into the front suspension.



88

View looking toward the front of the transmission and crossmember. There was burned fluid on the left side (driver's) exhaust pipe.



89

View of the underside of the engine oil pan and the transmission bellhousing. The underside of the engine was not burned.

90

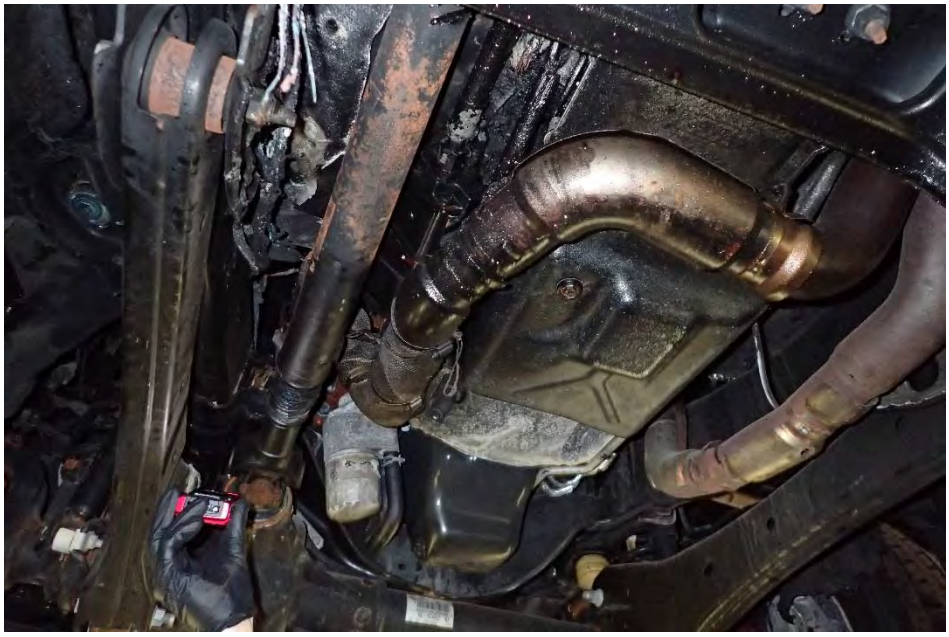
Overview of the automatic transmission and the exhaust pipes. The fire originated under the left side of the transmission. It represented the area of origin and the highest mass loss of material. The video surveillance shows the area of origin was on the left side of the transmission, which was consistent with the physical evidence.

91

Closer view of the fire- related damage under the left side of the truck cab. The heat wrapping on the exhaust pipe was saturated with transmission fluid.

92

Rear view showing the left side of the transmission. The area of origin is clearly defined by the fire patterns.

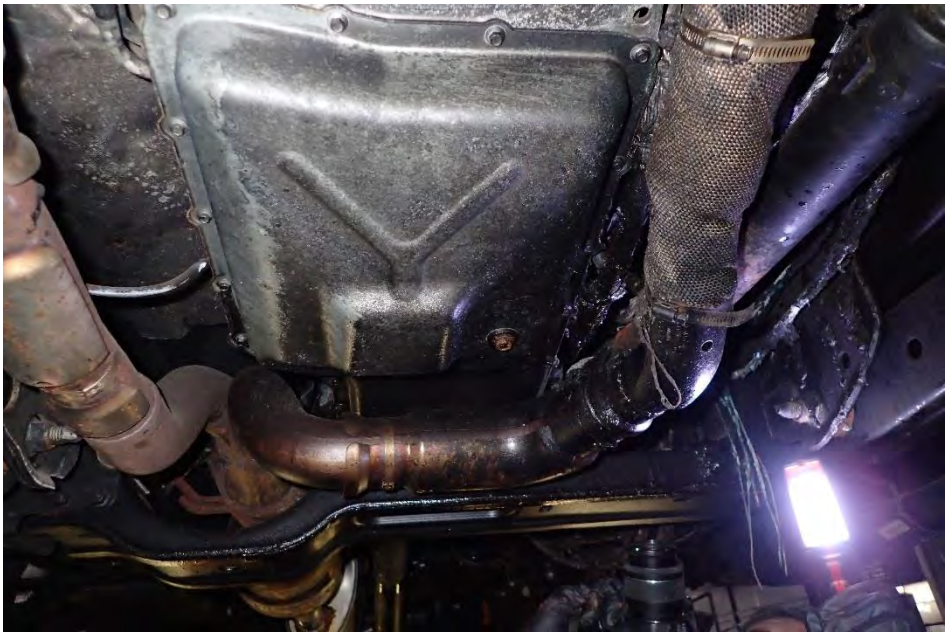


93

View of the left rear of the V10 gasoline engine. It was not burned.

94

View looking at the front of the automatic transmission oil pan and the exhaust crossover pipe. The fire was intensified after it vented up through the large hole in the floor pan that accommodates the 4-wheel drive gearshift.

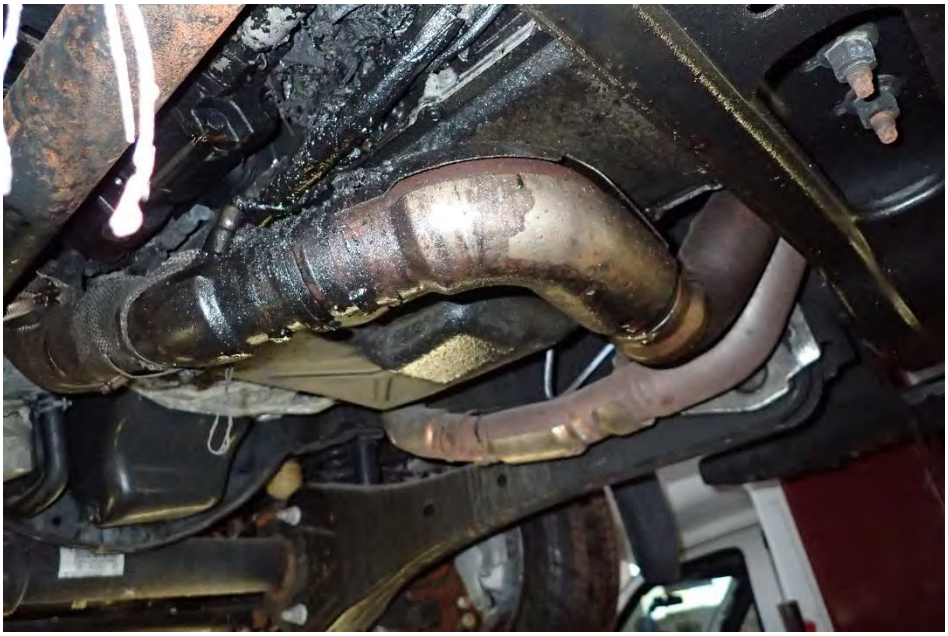


95

View looking at the rear of the automatic transmission oil pan. Burned oil could be seen on the exhaust pipe and underneath the left side of the floor pan. There was a defined fire pattern on the left side of the transmission pan.

96

Closer view looking at the left rear of the automatic transmission. The opening in the floor is located directly above. This allowed the fire to vent freely up into the cab of the truck, which intensified the heat release at the left side of the transmission.

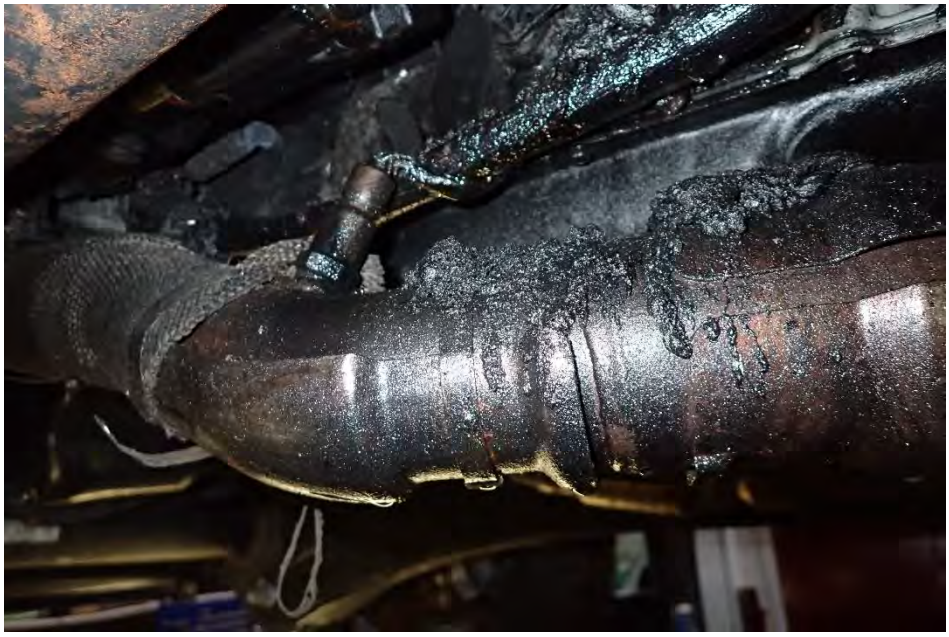


97

Closer view of the left side of the transmission. The exhaust pipe was soaked with fluid. The PTO pump and the reservoir line can be seen directly above the exhaust pipe.

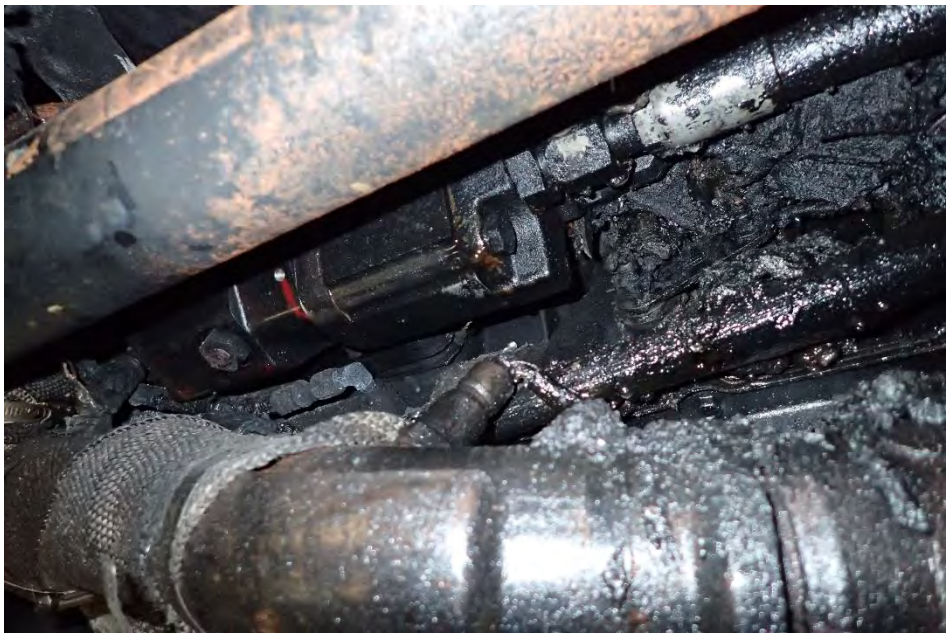
98

Close view of the exhaust pipe and an O2 sensor on the top of the pipe. The pipe was covered with burned transmission fluid.



99

Another view showing the left side exhaust pipe. The PTO pump and the reservoir line can be seen above the exhaust pipe. The transmission test port and the pressure line to the PTO can be seen just below the PTO pump.



100

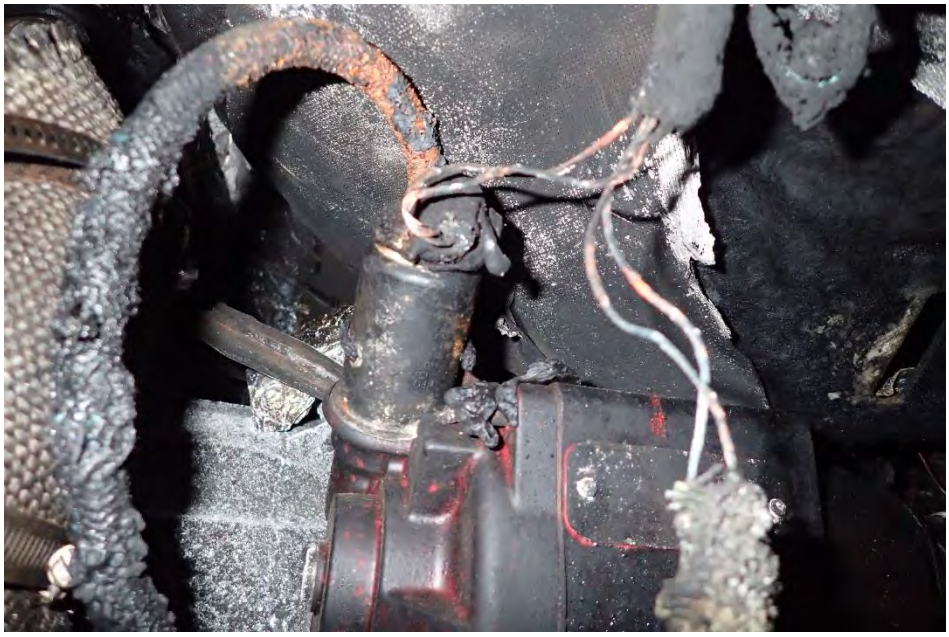
View of the transmission test port and the aftermarket transmission line extending to the PTO control switch.

101

View of the left side of the PTO where it mounts to the side of the transmission. The pressurized transmission line can be seen looping around the front of the PTO where it connects to the switch on top of the PTO.

102

View of the integrated cartridge valve and pressure switch on the PTO pump housing. Note that the transmission line was rubbing the floor pan directly above.

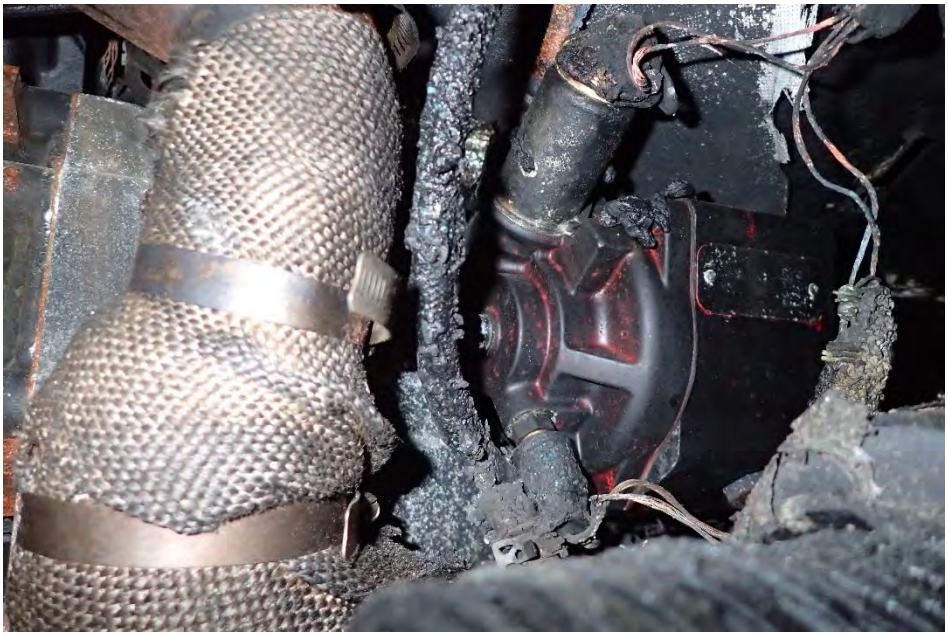


103

View of the front of the PTO pump and the transmission pressure line located in close proximity to the hot surface of the exhaust.

104

Closer view showing the burned transmission line located between the PTO pump and the exhaust. The PTO line should have been run in a different route where it would not come in close proximity to the exhaust pipe.



105

View of the burned pressurized transmission line extending from the transmission to the PTO switch. It was in close proximity to the exhaust pipe.

106

View of the underside of the engine and transmission before removing the exhaust pipes for inspection purposes.

107

View of the left side framerail of the truck. The left side exhaust pipe and the crossover can be seen below the transmission. The wrapping was soaked with transmission fluid and fluid was burned onto the surface of the pipe.

108

Closer view of the exhaust pipe located just below the PTO pump. This view was taken from the right side.

109

The exhaust pipes were unbolted from the exhaust manifolds and removed from the truck.

110

View of the right side exhaust pipe. There was no fluid on the right side pipe.

111

View of the left side exhaust pipe and the heat tape that someone had applied to the pipe.

112

Another view of the left side pipe showing the heat tape and burned transmission fluid.

113

View of the right side of the transmission after removing the exhaust pipe. Nothing was burned.

114

View of the left side of the transmission after removing the exhaust pipes. The PTO pump and the transmission pressure line can be seen.

115

Closer view of the PTO pump. The shift cable can be seen below the pump.

116

Closer view of the PTO pump and the shift cable. The transmission line is located just below the PTO pump.

117

Closer view of the pressurized transmission test port and the aftermarket transmission line installed for the PTO pump activation.

118

Close view of the aftermarket line connected to the transmission test port. This line is pressurized anytime the engine is running. When the PTO activates, the engine RPM and the pressure increase.

119

Close view of the transmission line where it passes in front of the PTO pump and in close proximity to the exhaust pipe and the shift cable.

120

Front view of the PTO pump showing the transmission line and the shift cable.

121

View of the pressurized transmission line where it extends to the activation switch on the PTO. When the exhaust pipe was removed, the upper portion of the pressurized transmission line was found to be fractured.

122

View of the shift cable where it passes in front of and under the PTO pump. The pressurized transmission line can be seen where it extends in front of the PTO pump.

123

The transmission pressure line was fused together with the housing on the gearshift selector cable.

124

Another view showing the transmission line extending from the transmission test port to the PTO. The hose was up against the pump housing and the gearshift selector cable.

125

Another view showing the hose where it extends up toward the top of the pump.

126

The hose was fractured where it had been up against the floor of the truck.

127

We detached the fitting from the transmission and lowered the gearshift cable and the transmission line down from the truck.

128

View of the pressurized transmission line and the gearshift cable.

129

Closer view of the broken end of the transmission line.

130

View of the front of the PTO pump showing the remains of the transmission line on the integrated cartridge valve and pressure switch.

131

Closer view of the broken transmission line.

132

View of the underside of the transmission.

133

View of the broken piece of the line after it was removed from the PTO.

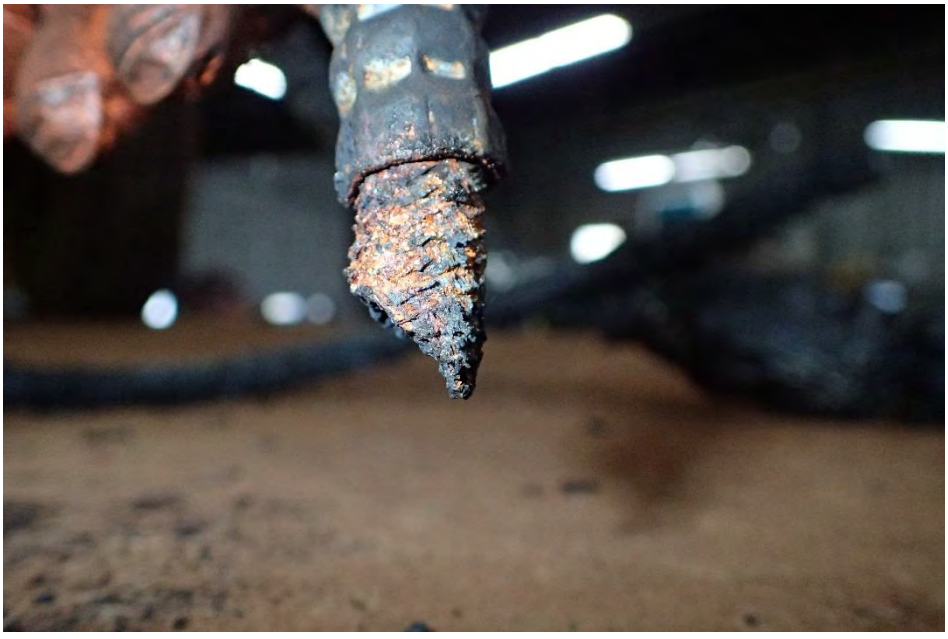
134

Another view showing the pressurized transmission line where it connected to the PTO pump.

135

View of the burned and fractured end of the line.

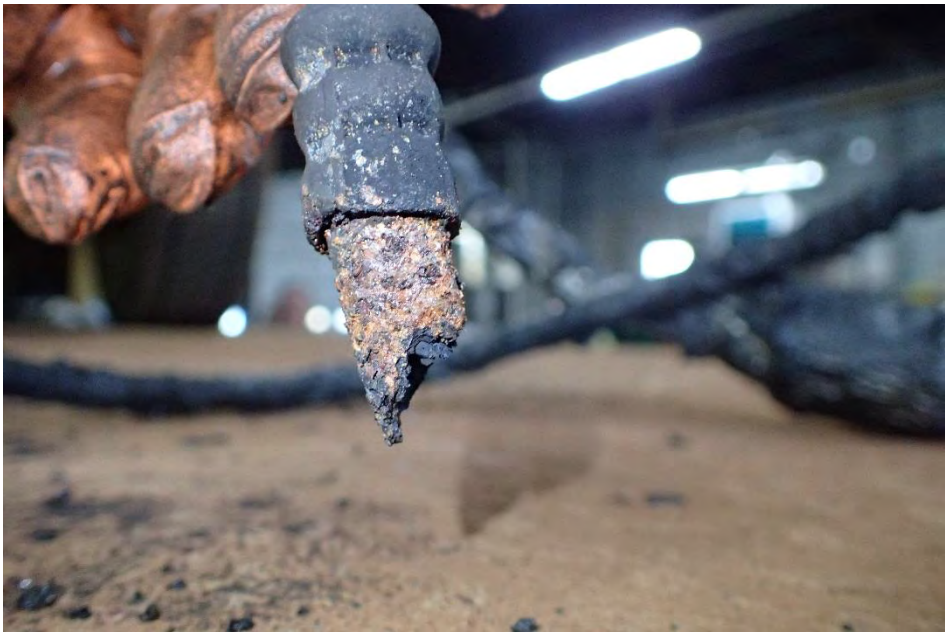
136



Another view of the fractured end of the line.

137

Another view of the fractured end of the line.



138

View of the upper end of the hose where it had been rubbing on the floor of the truck.

139

View of the end of the line where it connects to the fitting on the transmission.

140

View of the transmission line and the gearshift cable.

141

We separated the transmission line from the gearshift cable and found that it was not rubbed through.

142

View of the Chelsea 249 series hydraulic pump removed from the Ford truck transmission.

143

Another view of the pump.

144

View of the integrated cartridge valve and pressure switch on the PTO pump.

145

Overview of the PTO pump.

146

View of the part # and serial # on the PTO pump.

147

View of the reservoir line and the pressure line removed from the back of the PTO pump.

148

View of the reservoir line and the pressure line.

149

View of the left side of the floor pan after removing the pump. The remains of the shift cable were still in place.

150

View of the opening in the floor above the left side of the transmission. This allowed the fire to vent up through the floor and created a high intensity fire pattern attributable to the ventilation and the presence of the fuel.

151

Another view of the relatively large opening in the floor above the left rear of the transmission.

152

View of the left side framerail. The fuel lines are located further back on the framerail and they were not in the area of the fire. I examined the wiring harnesses remaining on the framerail.

153

The insulation still remained on some of the wires along the left framerail. I found no evidence of electrical activity.

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