NATIONAL TRANSPORTATION SAFETY BOARD
Investigative Hearing

Washington Metropolitan Area Transit Authority Metrorail train 302 that encountered heavy smoke in the tunnel between the L'Enfant Plaza Station and the Potomac River Bridge on January 12, 2015

GROUP	B
EXHIBIT	
2	

Agency / Organization

NTSB

Title

Fire Investigation Factual Report

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

4/10/2015

FIRE INVESTIGATION FACTUAL REPORT Report No. 15-039

A. ACCIDENT INFORMATION

Place	:	Washington, DC
Date	:	January 12, 2015 3:15 p.m. eastern standard time
Vehicle	:	WMATA train #302 Yellow line
NTSB No.	:	DCA15FR004
Investigator	:	Robert Gordon

B. GROUP MEMBERS

Joseph Panagiotou	NTSB
Tom Jones	WMATA
Corey Walker	FTA
Chad Campanell	ATF
Michael Pavero	MPDC

C. ACCIDENT SUMMARY

On January 12, 2015, about 3:15 p.m., Eastern Standard Time, Washington Metropolitan Area Transit Authority (WMATA) Metrorail train 302 stopped after encountering an accumulation of heavy smoke while traveling southbound in a tunnel between the L'Enfant Plaza Station and the Potomac River Bridge. After stopping, the rear car of the train was about 386 feet from the south end of the L'Enfant Plaza Station platform. The train operator contacted the Operation Control Center (OCC) and announced that the train was stopped due to heavy smoke.

A following train (train 510), stopped at the L'Enfant Plaza Station at about 3:25 p.m., and was also affected by the heavy smoke. This train stopped about 100 feet short of the south end of the platform. Passengers of both trains, as well as passengers on the station platforms, were exposed to the heavy smoke. Train 510 was evacuated while it was stopped at the station platform, where arriving police officers provided assistance in guiding passengers to the surface. Some passengers aboard Train 302 began to self-evacuate as it remained in the tunnel. Emergency responders were dispatched to the scene and an evacuation of the train and station area ensued.

Both Metrorail trains involved in this incident consisted of six passenger cars and were about 450 feet in length. As a result of the smoke, 86 passengers were transported to local

medical facilities for treatment. There was one passenger fatality. Initial damages were estimated by WMATA at $120,000.00.

Atmospheric Conditions at the time of the incident were reports as rain/mist, calm winds and 37 degree ambient temperature. (Weather reported from Reagan National Airport, about 1 mile south of the tunnel portal near the Potomac River Bridge)

The parties to the investigation include the Washington Metropolitan Transit Authority, the Federal Transit Administration, the Tri-State Oversight Committee, the Amalgamated Transit Union 689, the International Fire Fighters Association 36, the District of Columbia Fire and EMS, the Metropolitan Police Department and the Bureau of Alcohol, Tobacco, Firearms and Explosives.

D. DETAILS OF THE EXAMINATION

Fan Shaft (FL1)

The heavy smoke (in the Metrorail January 12, 2015 incident) is consistent with an electrical arcing event that occurred in the proximity of an emergency exit/ventilation fan shaft, FL1, located along the L-line of the WMATA metro system. FL1 vents above ground near the intersections of 9th Street and Water Street SW Washington DC. Evidence of electrical arcing was found in the track #2 tunnel bore of the L-line near the platform located at the bottom of FL1 between the stations of L'Enfant Plaza and Pentagon (figure 1). The L-line track segment is used by the yellow line train.

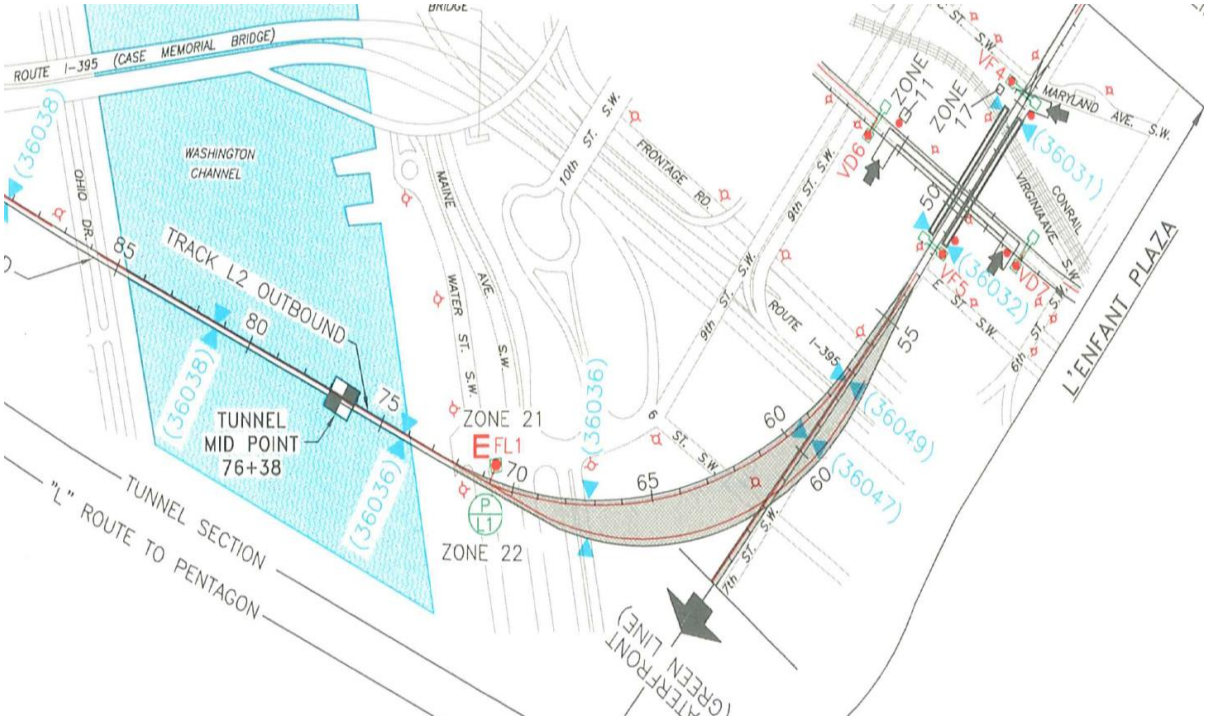

Figure 1: Drawing of a portion of the L-Line segment showing FL1 location.

FL1 serves as a ventilation fan shaft as well as an emergency exit that can be used in the event a train has to be evacuated while inside the tunnel. At the base of the FL1 shaft there is also a drainage water pumping station. The fan shaft has four fans at the top that can operate in either supply or exhaust mode and can be controlled locally or remotely from the operations control center (OCC). The four fans each have a capacity of 50,000 cubic feet per minute (cfm) in exhaust and 35,000 cfm in supply. At the bottom of the fan shaft is the emergency exit platform where trains can pull up and disembark passengers from either track #1 or track #2 of the L-line. Passengers evacuating through the tunnel can also step up to the evacuation platform from the track bed at this location. Other than at the bottom of FL1, the bores for track #1 and track #2 are separate from each other. Because FL1 is intended as an emergency exit, there is a discontinuity in the 3rd rail along the length of the emergency exit platform so that passengers do not have to step over the 3rd rail when evacuating. This is the same for tracks #1 and #2 on either side of the platform. In order to maintain electrical continuity of the 3rd rail, jumper cables are used to bridge the gap (figure 2).

Figure 2: Emergency exit platform at the Intersection of L-line Track #2 and FL1.

There were four jumper cables that electrically joined the two sides of the 3rd rail (figure 3). Each jumper cable consisted of a long portion of relatively stiff cable (power feed cable) with portions of more flexible cable (pigtails) connected at either end. Both of the types of cable were of equivalent electrical capacity. The connections between the power feed cable and pigtail cable were bolted connections. An insulating “boot” covered these connections. The connections between the pigtail cables and the 3rd rail were welded connections.

Diagram of jumper cable layout joining north and south segments of the 3rd rail at the incident site

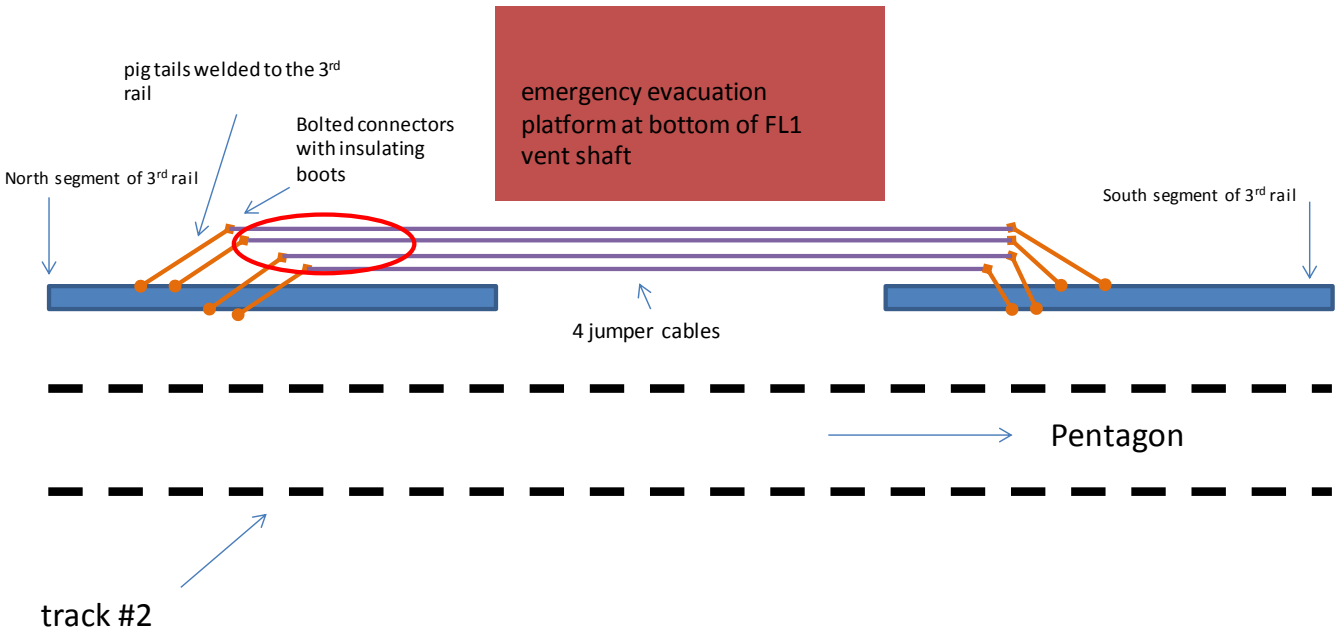

Figure 3: Diagram (plan view, not to scale) depicting jumper cable installation at the accident site. The area circled in red is where the majority of electrical arcing occurred.

The accident site examination indicated that electrical arcing had taken place among the power jumper cables that bridge the gap in the 3rd rail. The arcing was concentrated among the jumper cables on the north side near their connection to the 3rd rail (figure 4). One area of electrical arcing against the 3rd rail was observed at the south side of the 3rd rail (figure 5).

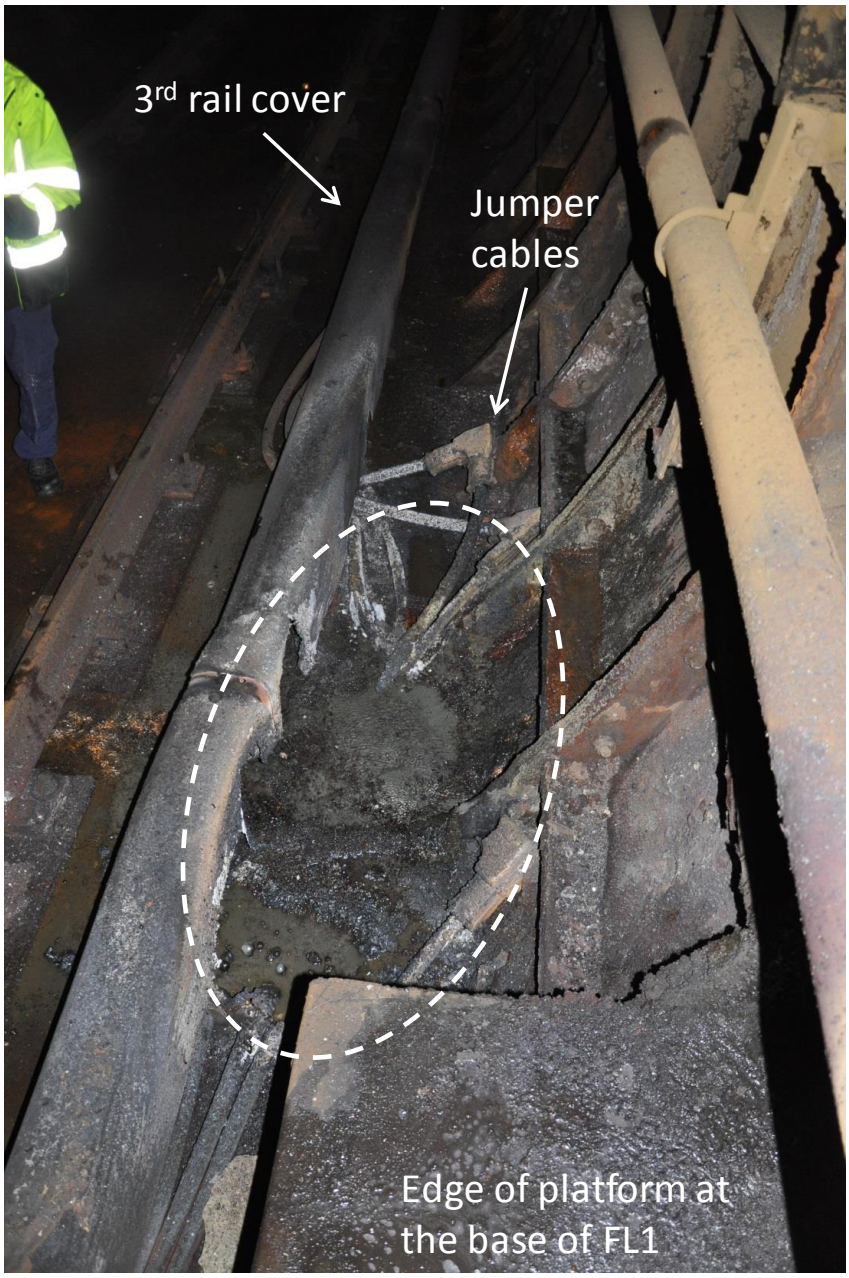

Figure 4: The majority of the electrical arcing and thermal damage was concentrated among the jumper cables. The area circled had missing portions of cable.

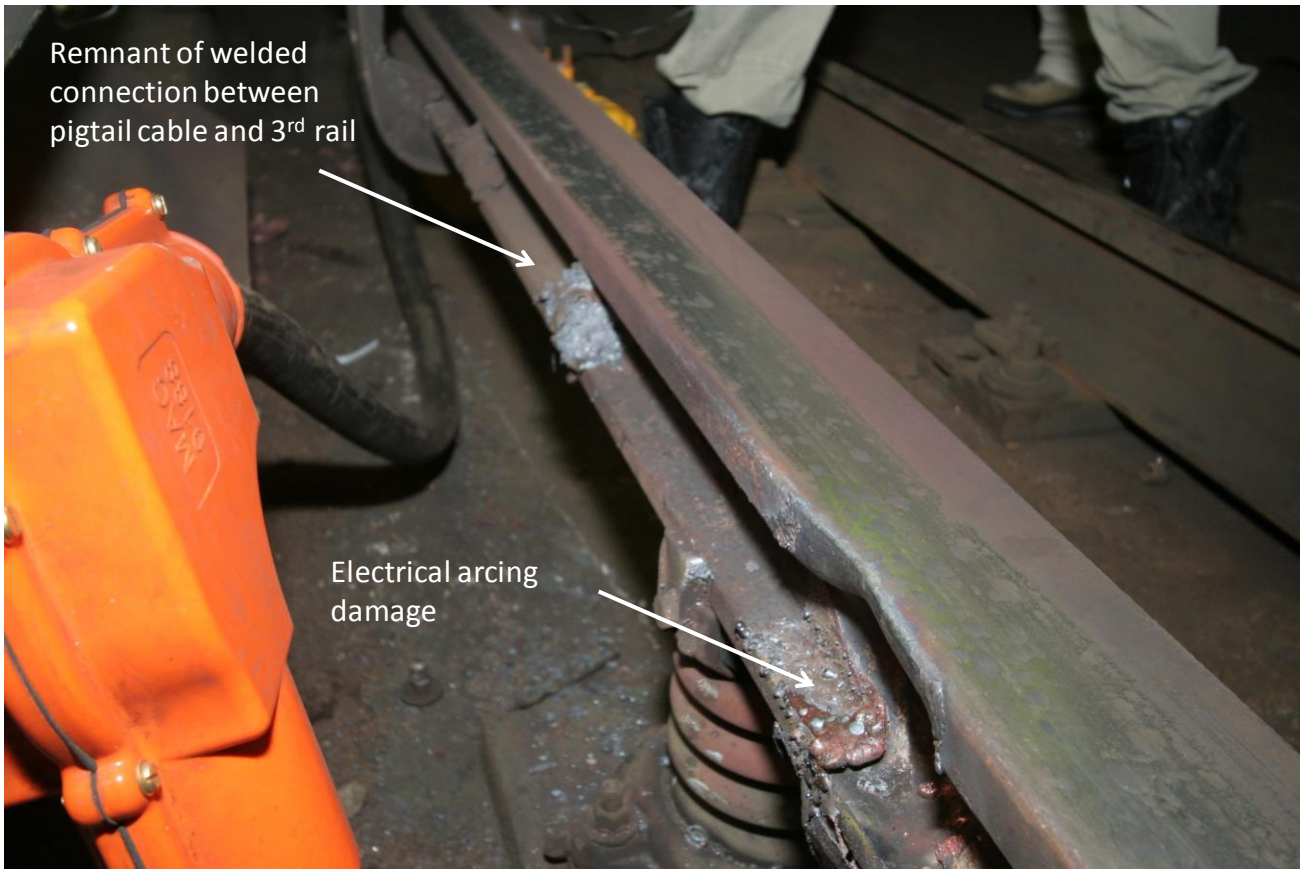

Figure 5: Electrical arcing damage to 3rd rail on south end.

The majority of the arcing and thermal damage took place on the north portion of the jumper cables in the area where the jumper cable connector boots were resting against the tunnel wall casing (Figures 4,6). The tunnel wall casing in this area was constructed of a ribbed, plate steel design with bolted connections among segments. One of the steel plates near floor level had evidence of copper splatter on it and seemed to be eroded or punctured. This area of splatter was directly behind the area where a cable connection appeared to have previously been. The connector and boot that would have been in this location were no longer present. One more of the cable connections in this same area was partially consumed. There appeared to be segments of cable missing from all four of the jumper cables. The ends of the severed cables had a melted and beaded appearance consistent with conductors that had gone through electrical arcing. Beyond the severed ends of the cable conductors the insulating sheathing had been burned back and thermally damaged. This damage to the insulation varied in the degree of how far back it extended from the exposed conductor. These damaged sets of jumper cables were retained for further examination and documentation at the NTSB laboratory.

The general area where the electrical arcing took place was wet. Pools of standing water existed where the cables had been laying. Water was freely flowing from an area of the tunnel casing where electrical arcing damage was observed. Water was also seen dripping from the tunnel casing above the location of the electrical arcing. The rusty appearance of the tunnel casing was consistent with prolonged exposure to moisture and corrosion.

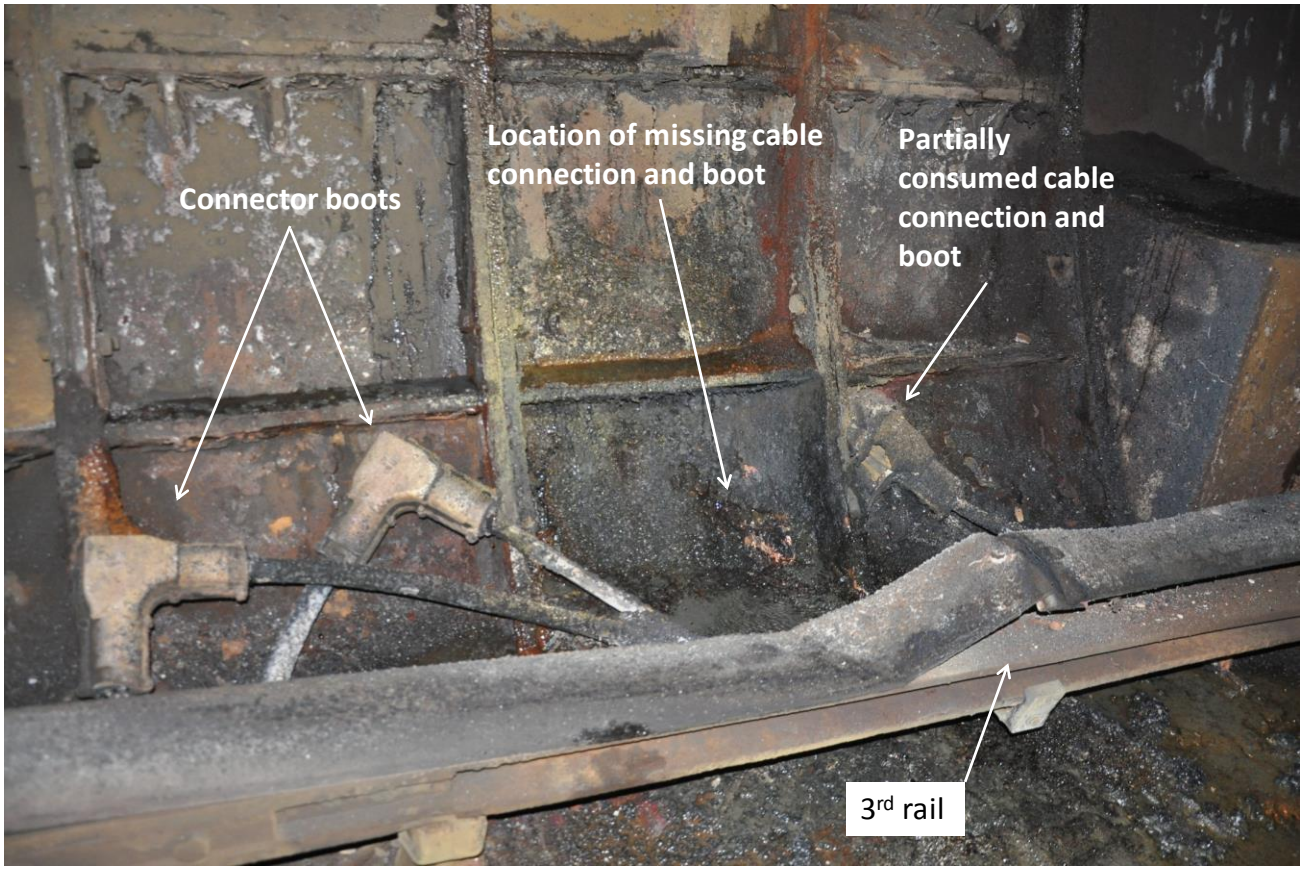

Figure 6: Damaged jumper cables resting against tunnel casing

There was a portion of 3rd rail in front of the location of the electrical arcing. This portion of the 3rd rail was covered by a fiberglass rail cover. The rail cover was thermally damaged exhibiting an area in which the polymer resin binder had completely volatilized leaving just the glass matrix behind. (figure 7). A horizontal soot trail and gradient of thermal damage along the interior face of the rail cover was consistent with air flow in the tunnel drifting towards the north (L'Enfant Plaza direction). This portion of the rail cover along with two more adjoining portions towards the north were retained for further examination at the NTSB laboratory. No evidence of any electrical arcing against the 3rd rail was observed on this north segment of the rail.

On the segment of the 3rd rail south of the emergency exit platform, a deposit of re-solidified metal was observed laying on the top surface of the 3rd rail (figure 8). On the surface of the 3rd rail facing the tunnel casing, directly below where the deposit was found, an area of damage from electrical arcing was observed (figure 5). The deposit was analyzed by x-ray fluorescence spectroscopy and found to consist mostly of iron with traces of copper.

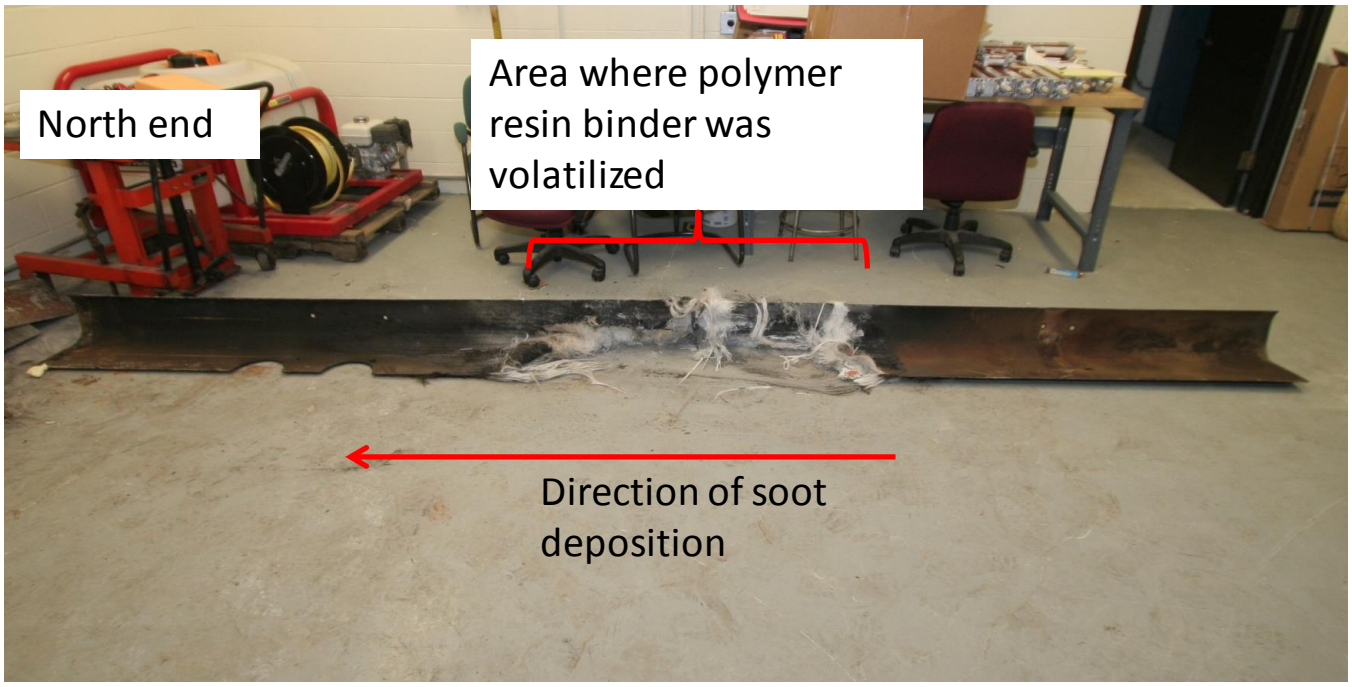

Figure 7: Thermal damage to the 3rd rail cover

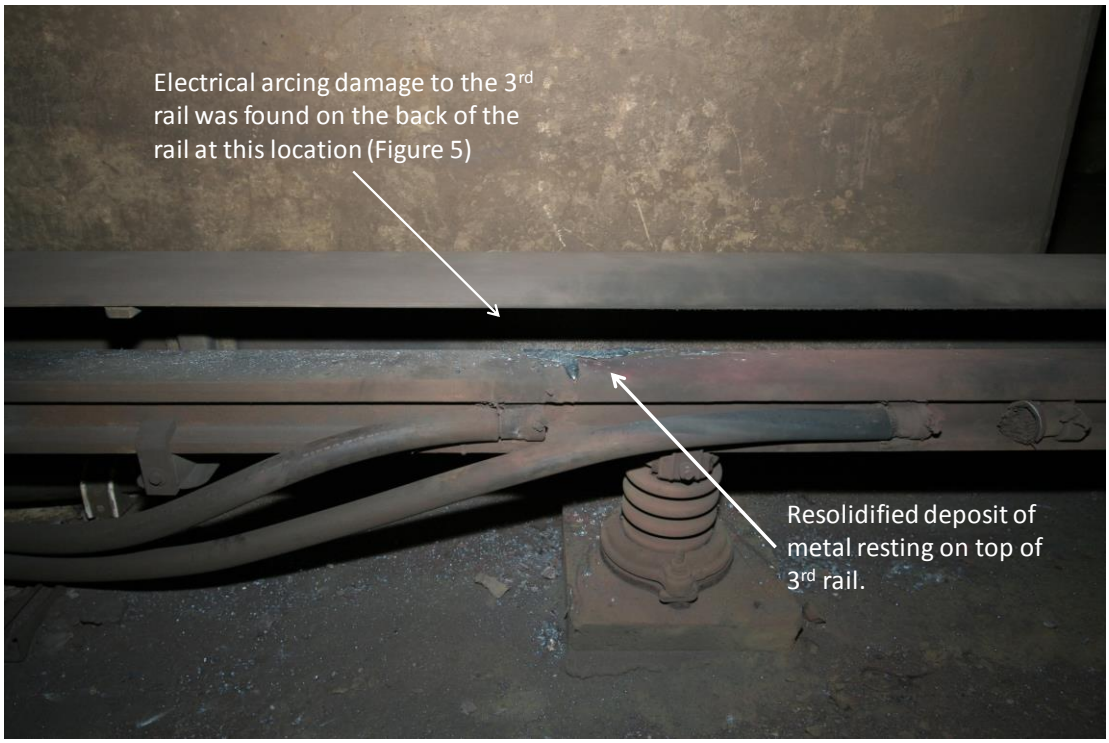

Figure 8: Resolidified metal deposit on South end of the 3rd rail.

A sample of debris was collected from the ground in the location of the electrical arcing among the jumper cables. Another sample of debris was collected for comparison from an

area across the track bed. These samples were collected by the ATF on the night of the accident and analyzed at their forensic laboratory. Neither of the two samples indicated the presence of hydrocarbon distillates.

Track #1 of the L-line had a similar jumper cable installation used to bridge the gap in the 3rd rail due to the emergency exit platform (figure 9). The environment where the cable connections and insulating boots were laying was not as wet as what was observed in Track #2. There was however moisture and water puddles along the track bed. The jumper cables were coated in a moist, mud-like debris (figure 10).

Figure 9: Jumper cable connections and boots on Track #1 of L-line at the North end of FL1.

Figure 10: Jumper cable with moist debris adhering to the insulation surface.

Track Walk

The morning after the incident, members of the Fire Group conducted a track walk from L'Enfant Plaza Station south down track #2 towards the portal exit. A short distance from the tunnel entrance, and just after the green line track junction departed towards the east, the back of train #302 was visible. This consist was comprised of 6 cars, a 3000 series married pair at the rear of the train, a 1000 series married pair in the middle of the train and a 6000 series married pair at the front. At the location of the lead car on the catwalk there was an emergency trip station for the 3rd rail power. From the front of the stopped train it was approximately another 1100 feet to the location where the electrical arcing had taken place. No anomalies were observed with the track or 3rd rail along this portion of the tunnel. Around the time the arcing event inside the tunnel is thought to have taken place, surveillance cameras facing outward from the L-line portal exit captured what appears to be an arc flash near the 3rd rail (figure 11). Examination of the rails in the area indicated by the video footage could not establish a definitive point of origin for the observed arc.

Figure 11: Arc flash captured on surveillance camera at the L-line portal exit at 15:06:20pm.

Examination of train #301

Train #301 had been the last yellow line train to pass through the accident site location prior to the arcing and smoke being observed. This train set was examined at the Alexandria Metro rail yard. This train had been out during the day after the incident running revenue service. The examination of this train focused on the current collector shoes and the overall appearance of the equipment in their vicinity. No anomalies or evidence of newly replaced parts were noted by either NTSB or WMATA staff.

Examination of train #302

Train #302 had been the train that stopped inside the tunnel during the accident. It was towed without power to the Greenbelt Metro rail yard and made available for examination. The exterior of the train on both sides did not exhibit any pronounced evidence of sooting beyond the normal operational/environmental fouling seen on the exterior of a typical rail car. The undercarriage was visually examined and no evidence of thermal damage was observed. On the interior of the lead car (6134) some fine soot was observed on most horizontal surfaces. This soot was very light and only perceptible when wiping with a finger. Near the ceiling by doors 8/7 (figure 12) soot trails were observed emanating from the vents of the air circulation system. Similar soot trails were seen at the vents near doors 5/6. The second car (6135) also exhibited soot deposition on horizontal surfaces but to a slightly greater degree than the 1st car. Soot trails were also observed at the ceiling vents near door 5/6. The 3rd (1285) and 4th (1284) cars also has some soot on the horizontal surfaces but to a lesser degree than the first 2 cars. Soot was not readily observed at the ceiling vents in these two cars. The 5th car (3030)

had a similar level of soot accumulation on the horizontal surfaces as the previous two cars. In this car, soot trails were observed at the vents near the ceiling on both sides of the car in the area between the forward and middle sets of doors. The 6th and last car (3031) also had soot on the horizontal surfaces similar to that seen in the 3rd through 5th cars. In this car, unlike the previous cars, the soot trails coming out of the vents at the ceiling appeared continuous along the length of the car on both sides (where there were vents). All the filters from the ventilation systems of the cars in this train consist were retained for further examination at the NTSB laboratory.

Figure 12: Soot trails seen at the ceiling vents.

Tunnel Smoke

On the basis of the L-line track examination, inspection of train #302 and the examination of the jumper cable installation at the bottom of FL1 the material responsible for the generation of smoke was identified. This material consisted of portions of the traction power jumper cables which had vaporized as well as portions of cable insulation that had burned back from the ends of the cables that remained. Additionally, one cable connection boot had vaporized as well as three boots that had partially been consumed. A thermally damaged portion of the 3rd rail cover board also contributed to the smoke production. It is also likely that due to the presence of water puddles at the location of the electrical arcing a volume of steam was also generated which would have augmented the smoke.

WMATA provided the investigative team with records of smoke detector activations around the time of the incident. The earliest smoke detector to go into alarm (Fire Zone Z22) was at 3:04:54PM[1]. This smoke detector was located above the drainage pump station at the

[1] The alarm times reported in this document have not yet been correlated with all of the time stamped data sources collected.

bottom of the FL1 vent shaft. The next smoke detector to go into alarm (Fire Zone Z02) was at 3:19:19PM. This smoke detector was located inside a service room just past the south edge of the south bound Green/Yellow line platform. The distance between these two smoke detectors (zone Z22 and zone Z02) was approximately 1936 feet and the time between their activation was 14m:25s. Based on these numbers the average speed of the smoke traveling through the tunnel towards L'Enfant Plaza was approximately 134 ft/min. A complete timeline of smoke detector activation is contained in a separate document provided by WMATA[2]

Tunnel Ventilation

WMATA provided documents and recorded data describing the fans and ventilation system operation at the time of the incident. These records indicate that the first command to the fans in the FL1 Vent shaft was given at 3:24:28PM. This command set the fans to exhaust. Prior to the fans in FL1 being activated in exhaust mode the under platform fans (UPE fan 2 and UPE fan 1) at L'Enfant Plaza station were commanded to exhaust mode at 3:16:09PM and 3:16:32PM respectively. A complete timeline of ventilation fan activation is contained in a separate document provided by WMATA[3]

Joseph Panagiotou
Fire & Explosion Investigator

[2] Fire Alarm Reporting- Summary L'Enfant Plaza Station F-03, D-03 Incident
[3] Fan Data F03 L'Enfant Station and Surrounding Location.