
NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



9/20/2015

MATERIALS LABORATORY FACTUAL REPORTReport No. 15-043

A. ACCIDENT INFORMATION

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

B. COMPONENTS EXAMINED

Portions of the four traction power jumper cable assemblies removed from the WMATA electrical arcing accident location near the bottom of fan shaft FL1.

C. DETAILS OF THE EXAMINATION

There were four jumper cable assemblies that electrically joined the two ends of the 3rd rail at the accident location. Each jumper cable assembly consisted of a long portion of relatively stiff cable (power feed cable) with portions of more flexible cable (pig tails) connected at either end (figure 1). All the cables examined had the specifications listed in figure 1 for the pigtails and power feed portions of the jumper cable assemblies. The connections between the power feed cables and pig tail cables were bolted connections. These bolted connections were designed to use cable connector assemblies (figure 2) consisting of lugs and sealing sleeves for each cable and a two-piece fiberglass cover. The fiberglass cover enclosed the bolted lug connection between the cables. The design of the cable connector assembly was specified to be weather tight. The connections between the pig tail cables and the 3rd rail were welded connections.

The four jumper cable assemblies were arbitrarily named A,B,C and D for this examination. The portions of cable comprising each jumper cable assembly will be described as "North end pig tail cable", "power feed cable" and "South end pig tail cable". It was not possible to match the portion of the south end pig tail cable to any of the jumper cable assemblies A,B,C or D.

Jumper Cable A

a. North end pig tail cable A

The recovered portion of the North end pig tail cable A was approximately 69 inches long (figure 3). The cable end that would have been welded to the 3rd rail was cut for removal. The cable end that would have had a lug and been bolted to the lug on the power feed cable was electrically damaged exhibiting fused and beaded strands. There was a sharp demarcation between the fused and beaded strands and the non-fused strands. The lug was missing from this cable and about 19 inches of the cable was missing insulation. There were about 14 inches of charred insulation leading up to the portion of the cable missing insulation. The undamaged portion of the insulation was covered with an orange or rust colored deposit¹. A sample of insulation was removed from this cable approximately 24 inches from what would have been the welded end of the pig tail cable. The conductor underneath the removed portion of insulation appeared clean with no evidence of corrosion (figure 4).

b. Power feed cable A

The recovered portion of the power feed cable A is shown in figure 5. The end that would have connected to the South end pig tail cable was cut during removal. The end that was connected to the North end pig tail cable still had the lug attached and a portion of its corresponding South end pig tail cable lug (figure 6). The portion of the South end pig tail cable A lug exhibited fusion damage consistent with electrical arcing. The cable connector cover was missing. Downstream of the lug on power feed cable A the insulation was missing over an approximately 19 inch length of the cable. The exposed conductor in this area was oxidized and exhibited some severed strands. Further downstream of the missing insulation was a length of approximately 5 inches of charred insulation. A section of insulation was removed 6 ½ inches downstream of the charred insulation. The conductor under the removed insulation was clean and did not exhibit any evidence of corrosion (figure 7).

Jumper Cable B

c. North end pig tail cable B

The recovered portion of the North end pig tail cable B was approximately 51 inches long (figure 8). The cable end that would have been welded to the 3rd rail was cut for removal. The cable end that would have had a lug and been bolted to the lug on the power feed cable was electrically damaged exhibiting fused and beaded strands (figure 9). There was a sharp demarcation between the fused and beaded strands and the non-fused strands. The lug was missing from this cable and about 2 1/2 inches of the cable was missing insulation. There were about 26 1/2 inches of charred insulation leading up to the portion of the cable missing

¹ Analysis of the composition of this deposit can be found in Materials Laboratory report 15-103

insulation. The undamaged portion of the insulation was covered with an orange or rust colored deposit. A portion of insulation was removed from this cable to examine the conductor. The conductor underneath the removed portion of insulation appeared clean with no evidence of corrosion (figure 10).

d. Power feed cable B

The recovered portion of the power feed cable B is shown in figure 11. The end that would have connected to the South end pig tail cable was cut during removal. The end that was connected to the North end pig tail was missing the lug and the conductor's strands were fused together (figure 12). Downstream of the fused end on power feed cable B the insulation was charred for approximately 12 inches on a portion of the circumference of the cable. A section of insulation was removed 10 inches downstream of the fused cable end. The conductor under the removed insulation was clean and did not exhibit any evidence of corrosion.

Jumper Cable C

e. North end pig tail cable C

The recovered portion of the North end pig tail cable C was approximately 48 inches long (figure 13). The cable end that would have been welded to the 3rd rail was cut for removal. The other end of pig tail cable C had a lug which was still bolted to the lug on the power feed cable. The lug on the power feed cable C had a portion approximately 34 inches long of cable still attached. This portion of power feed cable had charred insulation and was missing the insulation over a length of 7 inches on the South end. The conductor in the section missing the insulation had an oxidized appearance and terminated at a fused end (figure 14). The lugs of the cable connector assembly were still intact and bolted together. Half of the cable connector cover was missing and the remaining half was thermally stressed (figure 15). A heat shrink insulation sleeve covered part of the cable and the attached lug on both the pig tail cable and power feed cable. No evidence of a sealing sleeve as indicated by the cable connector assembly drawing (figure 2) was found. A portion of insulation was removed near the lug end of the power feed cable to assess the condition of the conductor underneath. The conductor was clean and did not exhibit any evidence of corrosion (figure 15). North end pig tail cable C had mostly intact insulation with some charring over a length of 12 inches from the lug end. The undamaged portion of the insulation was covered with an orange or rust colored deposit.

f. Power feed cable C

The recovered portion of the power feed cable C is shown in figure 16. The end that would have connected to the South end pig tail cable was cut during removal. The end leading to the North end pig tail was missing the lug and the conductor strands were fused together (figure 17). A portion of this power feed cable including the lug were still attached to the North end pig tail cable C. Near the fused end on power feed cable C the insulation was charred for approximately 5 inches on a portion of the circumference of the cable. A section of insulation was removed 12 inches away from the fused cable end. The conductor under the removed insulation was clean and did not exhibit any evidence of corrosion.

Jumper Cable D

g. North end pig tail cable D

The recovered portion of the North end pig tail cable D was approximately 43 inches long (figure 18). The cable end that would have been welded to the 3rd rail was cut for removal. The other end of pig tail cable D had a lug which was still bolted to the lug on the power feed cable. The lug on the power feed cable D had a portion approximately 17 inches long of cable still attached. This portion of power feed cable was mostly missing the insulation except for a small portion near the lug end. The conductor in the section missing the insulation had an oxidized appearance and terminated at a fused end (figure 19). The lugs of the cable connector assembly were still intact and bolted together. Half of the cable connector cover was missing and the remaining half was thermally stressed (figure 19). A heat shrink insulation sleeve covered part of the cable and the attached lug on the pig tail cable. The heat shrink insulation was mostly charred and consumed on the power feed cable end. No evidence of a sealing sleeve as indicated by the cable connector assembly drawing was found. North end pig tail cable D had mostly intact insulation with some thermal stress near the lug end. The undamaged portion of the insulation was covered with an orange or rust colored deposit.

h. Power feed cable D

The recovered portion of the power feed cable D is shown in figure 20. The end that would have connected to the South end pig tail cable was cut during removal. The end leading to the North end pig tail was missing the lug and the conductor strands were fused together (figure 21). A portion of this power feed cable including the lug were still attached to the North end pig tail cable D. Near the fused end on power feed cable D the insulation was charred for approximately 5 inches on a portion of the circumference of the cable. A section of insulation was removed 11 inches away from the fused cable end. The conductor under the removed insulation was clean and did not exhibit any evidence of corrosion (figure 22).

South end pig tail cables

Of the south end pig tail cables only one was removed and not reused when the track was put back in service. It was not possible to identify which of the jumper cable assemblies this pig tail cable had been a part of. This pigtail cable had the lug still attached on one end (figure 23). The other end which would have been welded to the 3rd rail had a fused end (figure 24). The insulation at the fused end was removed and no evidence of corrosion was identified along the exposed conductor. The demarcation between fused and non-damaged conductor was very sharp.

Cable Connector Covers

The cable connector covers that were provided to the NTSB originated from the south end of the jumper cable assemblies. It was not possible to determine which covers went with a particular jumper cable assembly. The covers were all the same type and did not have any features that would distinguish one from another. Both the exterior (figure 26) and interior

(figure 27) surfaces of the covers were contaminated with a dark colored deposit. A sample of this dust was collected for analysis. A sample of debris was also collected from the surface of one of the pig tail cables for comparison. The results of this analysis are contained in Materials Laboratory Report 15-103.

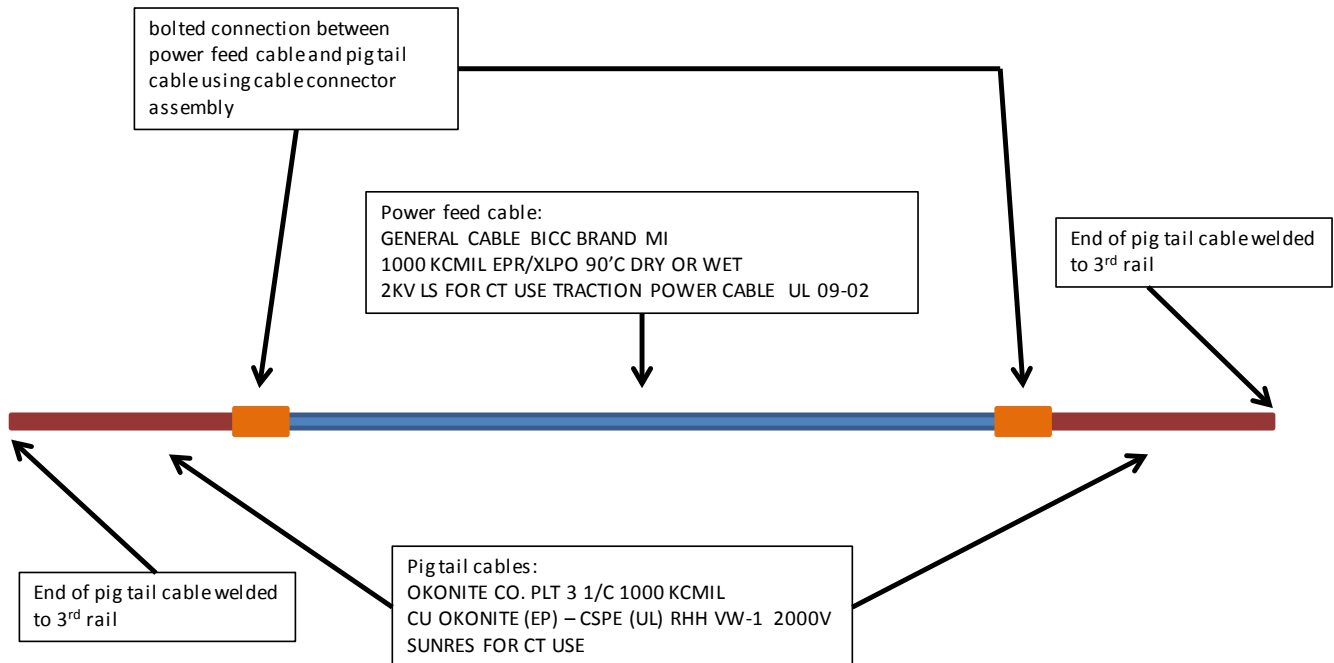


Figure 1: Diagram of general jumper cable construction.

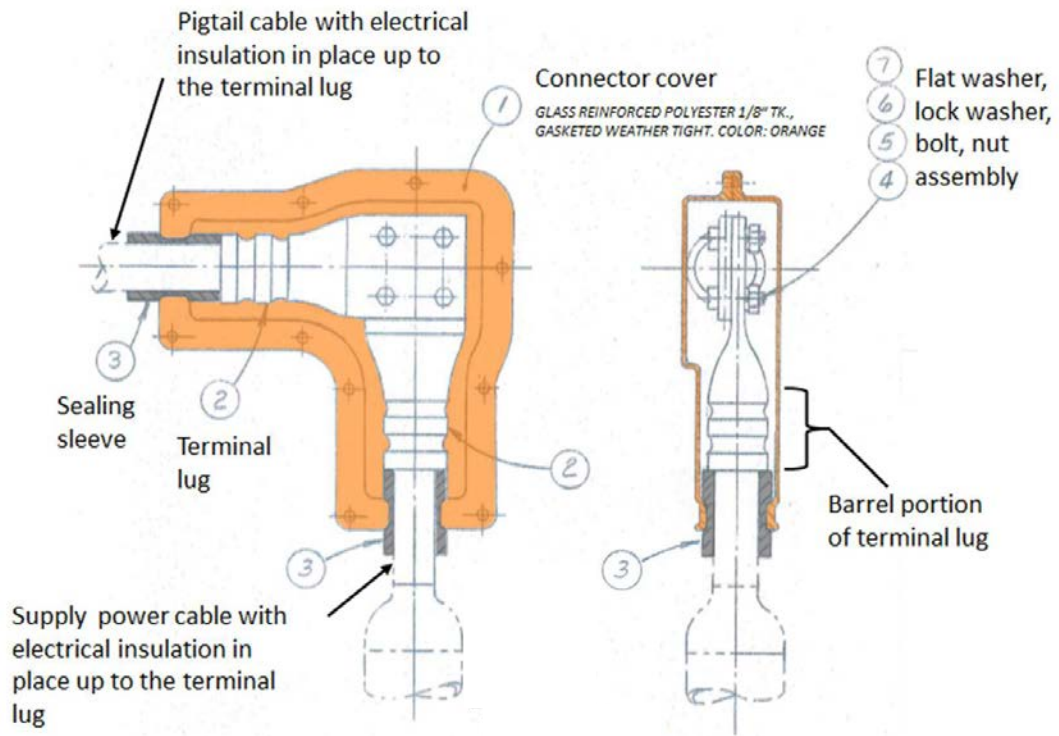


Figure 2: Cable connector assembly drawing.



Figure 3 North end pig tail cable A.



Figure 4: Portion of insulation removed from pig tail cable A.



Figure 5: Portion of power feed cable A.



Figure 6: Remaining portion of the bolted connection between North pig tail cable A and power feed cable A.



Figure 7: Portion of insulation removed from power feed cable A.



Figure 8: Portion of North pig tail cable B.



Figure 9: North end pig tail cable B with fused strands on the end.



Figure 10: Insulation removed from portion of North end pig tail cable B.



Figure 11: Portion of the power feed cable B.



Figure 12: Fused end of power feed cable B.



Figure 13: Portion of North pig tail cable C with a portion of power feed cable C attached.



Figure 14: Fused end on portion of the power feed cable C still attached to the North end pig tail cable C.



Figure 15: Insulation removed from portion of power feed cable C still attached to North end pig tail cable C.



Figure 16: Portion of power feed cable C.



Figure 17: Fused end on North end of power feed cable C.

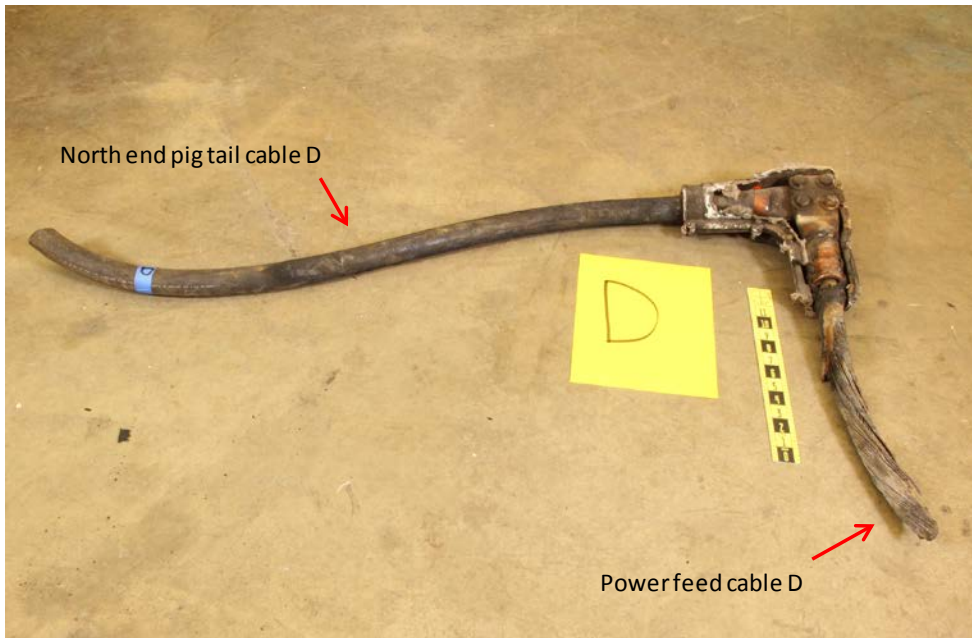


Figure 18: Portion of North end pig tail cable D with a portion of power feed cable D still attached.



Figure 19: Fused end on portion of the power feed cable D still attached to the North end pig tail cable D.



Figure 20: Portion of power feed cable D.



Figure 21: Fused end on portion of power feed cable D.

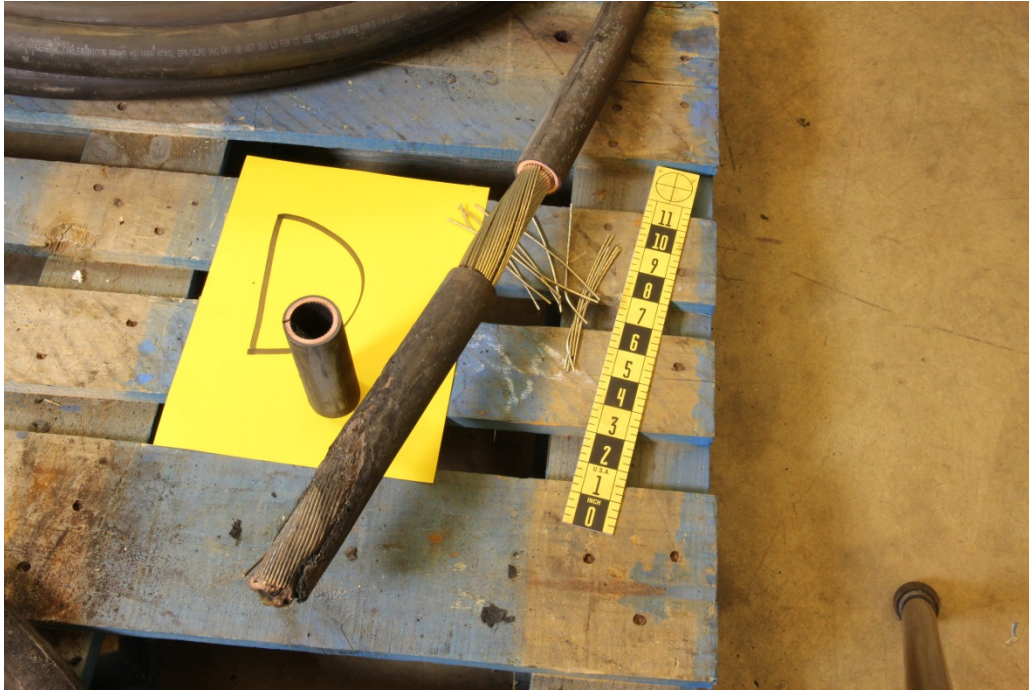


Figure 22: Portion of insulation removed from power feed cable D.



Figure 23: South end pig tail cable.



Figure 24: Fused end of South end pig tail cable.



Figure 25: Fused end of South end pig tail cable with insulation removed.



Figure 26: Cable connector cover exterior.



Figure 27: Cable connector cover interior.