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	C
EXHIBIT	
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Agency / Organization

WMATA

Title

Section 6.14 – Contact Rail Installation

CONTACT RAIL.
COVER BOARDS
INSULATORS

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CONTACT RAIL INSTALLATION

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SECTION 6.14

CONTACT RAIL INSTALLATION

6.14.1 DESCRIPTION

The work to be performed under this section shall include the complete installation of an operable contact rail system consisting of 150 NMC steel contact rail, composite contact rail and all appurtenances including protection equipment and electrical connections as specified.

Unless otherwise specified, the term contact rail and all works described applies to both 150 NMC steel contact rail and composite contact rail.

6.14.2 INSULATOR ASSEMBLIES

Insulator assemblies shall be installed as shown and specified.

The insulator base shall be centered and secured in place and shimmed for the contact rail insulator assembly.

Insulator assemblies shall be installed on the direct fixation invert or on the contact rail ties as shown. The distance between insulator assemblies shall not exceed ten feet.

All injurious substances falling on the insulators shall be immediately removed to prevent damage. Upon completion of the work, all insulators shall be inspected and thoroughly cleaned. All insulators chipped, broken or otherwise defective after installation shall be replaced before final acceptance at no additional cost to the Authority.

The top surface of each rail clip within a distance of 100 feet of an end approach or expansion joint shall be thoroughly coated with a non-conductive lubricant, Dow-Corning 44 (heavy) grease, or equal, to reduce strain on the insulator assemblies caused by the movement of the contact rail.

6.14.2.1 Ballasted Track Installation

The insulator assemblies shall be located to permit positioning the contact rail with respect to the gauge line of the near running rail within the specified tolerances.

The insulator assemblies shall be secured to the contact rail ties by two 1/2-inch by 6 1/2-inch drive spikes per insulator base. Insulator assemblies with 9/16-inch diameter mounting holes shall not be used for BTC.

Contact rail ties shall be bored in the field to receive the drive spikes. The holes shall be 3/8-inch in diameter and six inches deep and treated with pentachlorophenol oil or creosote immediately after boring. The drive spikes shall be started vertically and driven straight. Drive spikes bent during installation shall be withdrawn and new drive spikes driven. Drive spikes shall be driven firmly to the top of the insulator mounting base.

6.14.2.2 Direct Fixation Track Installation

The location of the insulator assemblies shall be as specified for ballasted track. Anchor bolts shall be]/2-inch diameter galvanized threaded studs. Anchor bolt holes for the insulator assemblies shall be located as shown and drilled as specified for DFTC. The diameter of the holes shall be as recommended by the manufacturer of the anchoring device, to a maximum of 1-3/4 inches.

Anchor bolts shall be installed in accordance with the approved procedure as specified for DFTC, except that the minimum upward vertical load shall be 9000 pounds. Anchor bolts shall be torqued to 1500 pounds tension.

6.14.3 CONTACT RAIL

The centerline of the contact rail shall be located as shown.

The contact rail shall be installed to rest evenly and uniformly on all insulator assemblies.

No length of contact rail less than 25 feet in length shall be used, except at locations shown unless otherwise approved. Cuts shall be made only as required to ensure that the end of a run of contact rail falls

within the specified tolerances. Cuts shall be made straight and perpendicular to the longitudinal axis of the contact rail. Contact rail for curve radii of less than 400 feet shall be bent to the appropriate curve prior to installation. Contact rail for curve radii greater than 400 feet may also be bent prior to installation to facilitate handling. The method of bending and tolerances to be allowed shall be submitted for approval.

6.14.3.1 Ballasted Track Installation

The required relative height of contact rail with respect to the top of running rail for timber ties shall be obtained by using additional high density polyethylene base pads as required. High density polyethylene base pads required for height adjustment shall be supplied by the contractor at no additional cost to the Authority.

6.14.3.2 Direct Fixation Track Installation

The required relative height of contact rail with respect to the top of running rail shall be obtained by varying the thickness of grout pads which will support the insulator assemblies as shown. The grout pads shall be as specified for DFTC, except that the dimensions shall apply to the insulator assembly instead of the running rail fasteners and shall be as shown for the contact rail assembly. If further height adjustment is required, additional high density polyethylene base pads, as required, up to 1/4-inch, shall be used in the insulator assembly. High density polyethylene base pads shall be supplied by the contractor at no additional cost to the Authority.

6.14.3.3 End Approaches

The ends of contact rail sections shall be terminated with end approaches, installed as shown. They shall be assembled to the contact rail to ensure a smooth running surface. The allowable longitudinal location tolerance shall be plus or minus six inches except at special trackwork locations where the distance measured from the nearest point of switch shall be as calculated from dimensions shown with a tolerance of minus zero and plus one foot. An 11-foot long end approach shall be used for all main track unless otherwise shown.

6.14.3.4.1 Splice Bar Joints for 150 NMC Steel Contact Rail

Splice bars with bolts, nuts and spring washers shall be installed between end approaches and adjacent steel contact rail sections as shown. The rail side of splice bars shall be coated with an approved rust preventative. All splice bar joints shall be installed to hold the end of the steel contact rail and end approach in alignment so that the top surfaces of the joined steel contact rail and end approach are continuous and true within 1/64-inch. Each bolt shall be tensioned to 1500 pounds.

6.14.3.4.2 Splice Joints for Composite Contact Rail

Composite contact rail splice joints shall be installed as specified by the manufacturer of the composite contact rail and approved.

6.14.3.5 Contact Rail Anchors

The contact rail anchors shall be installed as shown. The longitudinal locations of the anchors shall be within 1-1/2 feet of that shown. The anchors shall be secured to the trackbed with 3/4-inch by 7-3/4 inch threaded studs in direct fixation track and 11/16-inch by six-inch drive spikes in ballasted track.

6.14.3.6 Welding for 150 NMC Steel Contact Rail

Lengths of steel contact rail shall be joined together by welding the end of abutting rails by means of a copper based exothermic welding system. The welding procedure and preparation of the rail shall be in accordance with the manufacturer's recommendations. The exact alignment of the rails in welding shall be such that the offset in the top surface of the abutting rail does not exceed 1/64-inch. The vertical or horizontal misalignment of the two rails at a welded joint shall not exceed 1/32-inch maximum when measured using a three-foot straight edge. After installation of steel contact rail, no weld shall be within six inches of an insulator assembly.

6.14.3.6.1 Qualification of Welding Process for 150 NMC Steel Contact Rail

Prior to production welding, the Contractor shall submit an exothermic welding procedure for approval. In addition, three welds made according to the submitted procedure shall be tested as specified. All tests

shall be performed by an approved independent testing facility at no additional cost to the Authority. The sample welds shall join two 18-inch sections of rail. The test section shall be placed on supports spaced on 30-inch centers with the weld centered between the supports. A load of 45,000 pounds shall be applied in the center of the span and held for three minutes. No cracks or other signs of weld deterioration shall be visible at any time.

Following the above test, the welds shall undergo a current carrying capacity test. A direct current of 3,000 amperes shall be passed through each length of rail for a sufficient time to raise the rail to a stable temperature, which shall be defined as being a rate of temperature change not exceeding 2C in 30 minutes. Temperature readings shall be made with the use of commercial thermometers of the mercury bulb type. The dc power supply shall have sufficient capacity to maintain a continuous current of 3,000 amperes for the duration of the test. To be acceptable, the temperature rise of the rail shall not exceed 40C above an ambient temperature of 30C.

If any of the sample welds fail either of the tests, the process will be disapproved and a revised procedure shall be submitted and tested.

6.14.3.6.2 Qualifications for Performing Welding of 150 NMC Steel Contact Rail

The Contractor shall prepare, in accordance with approved methods and procedures, two sample steel contact rail welds under the direction of each foreman who will head a crew performing steel contact rail welds. The welds shall undergo the tests specified for qualification of the steel contact rail welding process.

The tests shall be performed by an approved independent laboratory at no additional cost to the Authority. Should any sample joint fail to pass either test, the foreman shall not be permitted to supervise the performance of steel contact rail welds for this Contract. When a crew performing welded joints has a change in foreman, the new foreman must be qualified as specified.

6.14.3.6.3 Quality Control of Welds of 150 NMC Steel Contact Rail

Welding of steel contact rail shall be performed under the direct supervision of a foreman qualified as specified.

When cooled to normal temperature, each steel contact rail joint shall withstand jacking or lifting to five inches above its normal position. When rail strings are resting on ties, this shall entail lifting five inches from the tie position. When the rail strings are already on insulator assemblies, this shall entail lifting five inches above the normal level the rail would have on the insulator assemblies. The lifting may be accomplished by a jack placed under the weld or by a lifting cable around the weld and a suitable hoisting device. All joints shall show no visible cracks in the weld.

All completed steel contact rail welds shall be tested individually to ensure proper conductivity of the joints. The test shall measure the resistance of 36 inches of steel contact rail containing a joint and adjacent 36 sections of steel contact rail on either side of the joint, using the voltage drop method. A direct current of at least 200 amperes shall be passed through the steel contact rail. The resistance measured across the weld shall be a maximum of 110 percent of both adjacent sections. All instruments, labor and materials necessary to perform these tests shall be provided by the Contractor at no additional cost to the Authority. Instruments for measuring voltage and current shall have an accuracy of 0.25 percent of full scale reading and shall have a mirrored 5-1/2 inch linear scale. All instruments shall have undergone certified calibration tests a maximum of six months immediately preceding the test. A copy of the calibration certification shall be submitted to the Engineer.

Any defective joint shall be removed by cutting out three inches either side of the weld and rewelding. The above tests shall then be performed on the new weld.

6.14.3.7 Contact Rail Surface Preparation

Upon completion of the contact rail to the specified tolerances, but prior to its final acceptance, the contact rail shall be brushed or otherwise cleaned to

remove rust and scale from the head of the contact rail. Such brushing or cleaning shall not remove in excess of 0.002 inch from any surface of the rails, except that additional brushing, cleaning or grinding shall be performed as necessary to remove local surface irregularities. The method of brushing, cleaning or grinding shall be submitted for approval prior to use.

6.14.3.8 Expansion Joints

Expansion joints shall be installed in the contact rails as specified at the locations shown with an allowable tolerance of plus or minus five feet. The expansion joint shall be installed to provide a flat surface uniform with the rails, ensuring that the top surfaces of the two sections are in line within 1/32-inch for a distance three feet in either direction. Expansion joint gaps shall be established depending on the rail temperature at the time of installation as shown on the Expansion Data Table. After installation the top surfaces of the expansion joint bars shall be ground so that they are flat and do not project above the top surface of the contact rail.

6.14.4 PROTECTION COVER ASSEMBLY

The protection cover assemply shall be installed entirely within the clearance envelope shown and in accordance with the manufacturer's recommendations as furnished by the Engineer.

At end approaches the protection cover shall be maintained at the uniform height above the top of the contact rail and shall drop with the end approach.

On curve radii under 500 feet, the protection cover may be cut into lengths a minimum of five feet long to conform as closely as possible to the arc of the curve. The protection cover shall lie within the clearance envelope at all times.

Additional protection cover brackets shall be installed where necessary. The maximum middle ordinate of a length shall be 1/2-inch. At contact rail expansion joints, an expansion joint protection cover assembly shall be installed as shown.

6.14.5 ELECTRIC CABLING AND CONNECTIONS

The electric cabling and connection work to be performed in this section shall be as shown and specified. Feeder cables from substations and tie breaker stations will be furnished and installed by others up to, but not including, the cable connector assemblies at the conduit terminations at the contact rail. All other contact rail cabling shall be installed by the Contractor. All cabling shall be continuous without splices between terminations.

Cables shall not be bent, either permanently or during installation, to radii less than 10 times the outer diameters, except where shorter radii are approved for conditions making the specified radius impractical. The Contractor shall provide suitable installation equipment to prevent cutting and abrasion of conduit and cable during installation. Wire pulling lubricants, if used, shall conform to applicable UL requirements. The lubricant shall be certified by the manufacturer to be non-injurious to such insulation. Pull-lines shall be made of nylon, polyester, polyethylene or other suitable nonmetallic material. Pull-lines shall be attached to cables by means of either woven basket grips or pulling eyes attached directly to the conductors. Only one cable shall be installed per conduit. Pulling tensions on both the conductors and their insulations and jackets shall not exceed the maximum tensions recommended by the cable manufacturer.

6.14.5.1 Expansion Joint Jumpers

Expansion joint jumper cable shall be extra flexible, 427-strand, power cable. Its length and points of connection to the contact rail shall be as shown. Jumper cables shall be supported as shown.

6.14.5.2 Cable Installed in Conduit

All jumper cable installed in conduit at crossovers, transitions and other special trackwork shall be standard duty, 127-strand, power cable. After installation, all cables shall be tested for insulation resistance to ground and between cables. Insulation resistance shall be tested with a 1000-volt megohmeter and shall not be less than one megohm. All conduit ends shall be sealed using heatshrinkable tubing as manufactured by Thomas & Betts Co., No. HS8400-225-1, or equal, installed according to the manufacturer's recommendations.

6.14.5.3 Contact Rail Connection Cable

Contact rail connection cable shall be extra flexible, 427-strand, power cable. Its length and points of connection to the contact rail shall be as shown, in accordance with expansion and contraction requirements of the contact rail.

6.14.5.4 Cable Connectors

6.14.5.4.1 Testing of Compression Connectors

Prior to installation, the Contractor shall have prepared, under the direction of each foreman who will supervise a crew performing compression connections, assemblies totaling one percent of the number of the assemblies to be installed. All test compression assemblies shall be made using the methods and equipment the Contractor proposes to use for the installation. The electrical resistance of the completed connection, when measured between the cable and the connector tongue, shall not be greater than the resistance of an equivalent length of uncut cable.

The test connections shall then be subjected to a sustained tension of 5,000 psi for three hours. At the end of three hours, there shall be no slipping of the cable in the connector, deforming or loosening of the connection or increase in the electrical resistance beyond that specified.

The test connections shall then be heated to 240C by passing an electric current throught the connection. After the temperature equalizes at 240C, the connection shall be cooled to 24C. A heating phase and a cooling phase shall constitute one cycle. The test connections shall undergo 100 cycles without increasing the resistance beyond that specifed. Should any sample fail to meet the specified test requirements, the qualification of the foreman and the equipment shall be disapproved. When a crew performing connections has a change in foreman, the new foreman and the equipment shall be qualified as specified.

6.14.5.4.2 Installation of Compression Connectors

Compression connectors shall be attached to the cable with the manufacturer's recommended tooling. When bolting tongues together, a lockwasher shall be installed under the head of each bolt and under each nut. All bolted connections shall be tightened with torque wrenches to a uniform torque of 450 inch-pounds.

6.14.5.5 Installation of Exothermic Connections of 150 NMC Steel Contact Rail

Cable connections to the steel contact rail shall be made by a copper-based exothermic welding system. The connection procedure and exact composition of welding powder shall be in accordance with the manufacturer's recommendations for the materials to be joined. All extraneous weld metal shall be removed.

6.14.5.5.1 Testing of Exothermic Connections of 150 NMC Steel Contact Rail

All exothermic connections shall be tested for mechanical strength using a two-pound hammer. A minimum of three sharp blows fifteen inches in stroke shall be directed to the weld nugget. The weld shall sustain the blows without cracking weld metal or at the interface with the steel contact rail. Defective welds shall be removed and the rail and cable thoroughly cleaned before rewelding. The Contractor shall submit an exothermic welding procedure for approval prior to production welding.

6.14.5.6 Terminal Lugs

6.14.5.6.1 Testing of Terminal Lugs for Composite Contact Rail

Terminal lugs for composite contact rail shall be tested as specified for compression connectors.

6.14.5.6.2 Installation of Terminal Lugs for Composite Contact Rail

Cable connections to the composite contact rail shall be one-hole, tin-plated, copper compression connectors. Prior to assembly of the terminal lugs to the composite contact rail, mating surfaces shall receive a liberal coating of oxide-inhibiting paste, NO-OX-ID, Dearborn Chemical, or equal. The oxide-inhibiting paste shall also be applied to all interfaces of the compression fasteners. The methods and equipment used to fasten the terminal lugs to the composite contact rail shall be as recommended by the manufacturer of the rail. Compression fasteners bent or improperly installed shall be replaced.

6.14.5.7 Disconnect Switch Assembly

Contact rail disconnect switch assemblies shall be completely installed, including cable connections and foundation, as shown.

Concrete for disconnect switch assembly foundations shall conform to ASTM C94, Class 3500, Alternative 3. Coarse aggregate shall be Size Number 57. When placed, the concrete shall have a slump of three inches maximum and an entrained air content of four percent. A mix design for the concrete shall be submitted for approval.

Concrete shall be measured, mixed, transported, placed and compacted in accordance with ACI 304 and given a wood float finish. Freshly placed concrete shall be protected in accordance with ACI 305R and ACI 306R. Concrete shall be cured in accordance with ACI 308.

6.14.5.8 Galvanizing

Bolts and miscellaneous hardware required to be galvanized, shall be coated in accordance with ASTM A153.

All other parts to be galvanized shall be galvanized after fabrication in accordance with the requirements of ASTM A123, unless otherwise specified.

Before galvanizing, the finished parts shall be pickled or sandblasted and the scale and adhering impurities throughly removed. The pickling shall be done in properly diluted sulfuric acid, after which the parts shall be thoroughly cleaned in cold, running water. Sandblasting shall meet or exceed Steel Structures Painting Council SSPC-SP 6 except that the maximum grit size shall be SAE No. G-18. The parts shall then be immersed in a solution of zinc chloride or hydrochloric acid. Immediately following thorough drying, the parts shall be dipped into the zinc bath before corrosion has started again.