

MARCH 27, 2019

NEW HAVEN RAIL YARD FACILITIES IMPROVEMENTS
WEST END YARD
FEDERAL PROJECT NO. CT-2018-014-00
STATE PROJECT NO. 0300-0138
CITY OF NEW HAVEN

ADDENDUM NO. 3

This Addendum addresses the following questions and answers contained on the “CT DOT QUESTIONS AND ANSWERS WEBSITE FOR ADVERTISED CONSTRUCTION PROJECTS”:

Question and Answer Nos. 88, 93, 97, 111, 118, 120, 121, 122, 125, 126, 128, 134, 136, 142, 144, 146, 148, 149, 150, 153, 154, 156, 159, 163, 164, and 165.

SPECIAL PROVISIONS
NEW SPECIAL PROVISIONS

The following Special Provisions are hereby added to the Contract:

- ITEM #0602052A – WELDED WIRE FABRIC – EPOXY COATED
- ITEM #0728008A – 3/8” CRUSHED STONE

REVISED SPECIAL PROVISIONS

The following Special Provisions are hereby deleted in their entirety and replaced with the attached like-named Special Provisions:

- ITEM #0001080A – JUNCTION BOX
- ITEM #0001130A – 500KCMIL, 15 KV SHIELDED COPPER CABLE
- ITEM #0001137A – 35 KV COPPER WIRE NO. 1/0 AWG
- ITEM #0001139A – 750KCMIL, 35 KV SHIELDED COPPER CABLE
- ITEM #0090042A - CATENARY SYSTEMS
- ITEM #0090045A - AERIAL GROUND WIRE SYSTEMS
- ITEM #0090074A – TRACTION POWER DISTRIBUTION SYSTEM
- ITEM #0100411A – 150 KVA PAD MOUNTED DISTRIBUTION TRANSFORMER

ITEM #0100416A – 750 KVA PAD MOUNTED DISTRIBUTION TRANSFORMER

- ITEM #0202452A – TEST PIT
ITEM #0202455A – TEST PIT (ESTIMATED COST)
- ITEM #0503471A - TURNOUT INSTALLATION
ITEM #0504010A - RAILROAD TRACK WORK
- ITEM #0686200.15A – 15" POLYVINYL CHLORIDE PIPE – 0’ – 10’ DEEP
ITEM #0686200.24A – 24" POLYVINYL CHLORIDE PIPE – 0’ – 10’ DEEP
- ITEM #1108798A – CENTRAL COMMUNICATIONS EQUIPMENT
- ITEM #1108873A – NETWORK VIDEO RECORDING (NVR) SYSTEM
ITEM #1112227A – FIXED MOUNT CAMERA DOME
- ITEM #1112302A – ACCESS CONTROL SYSTEM
- ITEM #1204252A – SERVICE CONSOLE
ITEM #1204253A – SERVICE CONSOLE PIPING
ITEM #1204254A – CLEANING CABINET
- ITEM #1301080A – 4” DUCTILE IRON PIPE (WATER MAIN)
ITEM #1301082A – 8” DUCTILE IRON PIPE (WATER MAIN)
ITEM #1301084A – 12” DUCTILE IRON PIPE (WATER MAIN)
ITEM #1302002A – 4” GATE VALVE
ITEM #1302004A – 8” GATE VALVE
ITEM #1302120A - 4” INSERTION VALVE (WATER MAIN)
ITEM #1302122A - 8” INSERTION VALVE (WATER MAIN)
ITEM #1302124A - 12” INSERTION VALVE (WATER MAIN)
ITEM #1302203A - 4”X4” TAPPING SLEEVE+VALVE
ITEM #1302206A - 8”X’8” TAPPING SLEEVE+VALVE
ITEM #1302207A - 8”X4” TAPPING SLEEVE+VALVE
ITEM #1302217A - 12”X12” TAPPING SLEEVE+VALVE
ITEM #1303204A – HYDRANT ASSEMBLY (WATER MAIN)
ITEM #1304083A – POLYETHYLENE ENCASMENT OF PIPE (WATER MAIN)
- ITEM #1403009A – MANHOLE-TYPE 2 (SANITARY SEWER)

DELETED SPECIAL PROVISION

The following Special Provision is hereby deleted in its entirety:

- ITEM #0001122A - 500KCMIL, 35 KV SHIELDED COPPER CABLE

CONTRACT ITEMS
REVISED CONTRACT ITEMS

<u>ITEM NO.</u>	<u>DESCRIPTION</u>	<u>ORIGINAL QUANTITY</u>	<u>REVISED QUANTITY</u>
0000468A	600V COPPER WIRE NO. 4/0 AWG	5,600 L.F.	11,020 L.F.
0001130A	500 KCMIL,15KV SHIELDED COPPER CABLE	12,080 L.F.	16,230 L.F.
0090074A	TRACTION POWER DISTRIBUTION SYSTEM	2,900 L.F.	3,000 L.F.
0096108A	DISCONNECT SWITCH AND SECTIONALIZING JUMPER TAPS	10 EA.	12 EA.
0602052A	WELDED WIRE FABRIC – EPOXY COATED	350 S.Y.	1300 S.Y.
1112227A	FIXED MOUNT CAMERA DOME	16 EA.	18 EA.

DELETED CONTRACT ITEMS

<u>ITEM NO.</u>	<u>DESCRIPTION</u>	<u>ORIGINAL QUANTITY</u>	<u>REVISED QUANTITY</u>
0000985	TRACK MONITORING	1 L.S.	0
0001122A	500 KCMIL,35KV SHIELDED COPPER CABLE	140 L.F.	0

PLANS

REVISED PLANS

The following Plan Sheets are hereby deleted and replaced with the like-numbered Plan Sheets:

Sheets: 02.001.A3, 09.077.A3, 11.002.A3, 11.012.A3, 11.018.A3, 11.019.A3, 11.020.A3, 11.021.A3, 11.022.A3, 11.026.A3, 15.022.A3, 15.037.A3, 15.038.A3, 15.040.A3, and 15.041.A3.

The Bid Proposal Form has been revised to reflect these changes.

There will be no change in the number of calendar days due to this Addendum.

The foregoing is hereby made a part of the contract.

ITEM #0001080A – JUNCTION BOX

Description:

Scope

The work under this item includes furnishing and installing NEMA 3R enclosures and NEMA 3R Non-fused switches (disconnects) at locations shown on the plans or as directed by the Engineer in accordance with these specifications. Included in this work is the installation and construction of stanchion, fittings, nipples, and gaskets as necessary.

Submittals

Submit the following in accordance with the Standard Specifications Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

Contractor shall submit product data with sufficient information, clearly presented, shall be included to determine compliance with plans and specifications.

Materials:

The pull box shall be of fully welded construction with a gasketed screwed cover, NEMA 3R rated, and color ANSI 61 gray. The bottom of the pull box shall be punched for the duct bank conduits. The pull box shall be mounted to the top of the duct bank conduits and secured on a stanchion, as designed and submitted by the Contractor.

Non-Fused Switches (Also known as disconnect switches): NEMA KS 1, Type HD; 600VAC, 60A, UL 98 listed, pad lockable handle.

- Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
- Neutral Kit: Internally mounted, insulated, capable of being grounded and bonded, and labeled for copper neutral conductors.
- Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.
- Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- Lugs: Mechanical type, suitable for number, size, and conductor material.
- Enclosure Type: NEMA 3R and color ANSI 61 gray.
- Labeled for use as service equipment.

Construction Methods:

Junction boxes, including disconnect switches, shall be sized and located as indicated on the plans. All disconnect switches shall be mounted on the exterior of the junction box and per the requirements of the NEC. Conduits and fittings shall be placed in proper positions and shall be secured permanently.

Method of Measurement:

Junction boxes shall be measured for payment for work complete, and accepted in place, which includes all disconnect switches, stanchions, fittings, nipples, gaskets, bushings, and all equipment, tools, labor and work incidental thereto.

Basis of Payment:

This work will be paid for at the contract unit price per each junction box installed and accepted, in place, including all materials, equipment, tools and labor incidental thereto.

<u>Pay Item</u>	<u>Pay Unit</u>
Junction Box	EA

ITEM #0001130A – 500KCMIL,15 KV SHIELDED COPPER CABLE

Description:

Scope

This applies to 100% insulated thermosetting ethylene propylene rubber (EPR) shielded and jacketed cable rated 15kV phase-to-phase for use on three-phase 60-hertz systems. The cables shall be suitable for installation in wet or dry environments and direct buried or in conduit for operation at a maximum normal conductor temperature of 90°C, emergency overload temperature of 130°C and short circuit temperature of 250°C. The cables shall be designed for and warranted in writing for 40 years of installed energized operation.

Quality Assurance

- A. Cable Manufacturers' Qualification: Not less than fifteen (15) years experience in the actual production of the specified products.
- B. Workmanship shall conform to the best modern practices in the manufacturing of a rugged, durable, and safe product for use in a public transportation system. Materials used shall be new and of the highest commercial grade as specified.
- C. The Insulated Cable shall be manufactured and tested under the control of a Quality Assurance system that conforms to the requirements of ISO 9000.
- D. The Quality Assurance system shall demonstrate conformance to the above criteria by having passed yearly quality audits conducted by outside independent organizations.
- E. Information regarding the manufacturer's Quality Program shall be furnished to the Engineer and United Illuminating upon request.
- F. Cable shall meet United Illuminating (UI) – Electric Systems Distribution Equipment Specification DES-110 “4CT, 15KV, 4/0, 500&750 Compact Round Copper Insulated, Jacketed Cable.

Submittals

The Contractor shall submit the following for review and approval of the designer at various stages of planning, manufacturing, and installation of cable and wire as requested:

- A. Descriptive literature, catalog data, and other pertinent information for cable splices sufficient to clearly demonstrate compliance with the Contract Documents.
- B. Cable pulling plan showing cable feed and pulling winch locations, cable lengths, and calculated pulling tensions for each cable pull over 200 feet in length, or with a total of 180° or more of conduit bends.
- C. Proposed cable lubricants and associated lubricating devices.
- D. Proposed cable pulling equipment including cable grips, pulling rope, tensiometers, swivels, and cable pullers (winches).
- E. Qualifications of all cable splicers proposed to be utilized for splicing work.
- F. As-built lengths of all cable installed under this Contract.
- G. Product Data: Shall consist of manufacturer's standard catalog cuts, descriptive literature and diagrams, in 8½ X 11-inch format, and in sufficient detail so as to clearly indicate compliance with all specified requirements and standards.
- H. Manufacturer's Certification: Manufacturer shall submit signed certification confirming that they comply with the qualifications requirements and shall provide evidence of experience upon request.
- I. Product Certification: Signed by manufacturer certifying that products comply with the specified specification requirements.
- J. Report of Field Tests: Certified copies of field tests.
- K. 24-inch long samples of the final assembled cables for First Article Inspection prior to release.
- L. Submit catalog cuts for the following:
 - 1. Wires and cables for each type and size
 - 2. Splice kit materials and installation procedures
- M. Submit certified shop test reports for wires and cables.

- N. Submit field test results for wires and cables, including megger readings with the method used.

Materials:

- A. Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. All cables shall comply with AEIC CS8-13, Specification for Extruded Dielectric Shielded Power Cables, Rated 5 through 46kV and ANSI/ICEA S-97-682-2013, Standard for Utility Shielded Power Cables Rates 5,000 – 46,000 volts, with options as detailed. The cables shall be assembled in the field, as a triplexed assembly including a bare 4/0 copper neutral.
- C. It shall be the responsibility of the manufacturer to insure compatibility among all components of the cable.
- D. The conductors shall be uncoated copper, compact round strand in accordance with ASTM Specification B496-16, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors. The conductors shall be sealed from water intrusion in accordance with ICEA S-94-649-2016, Part 2.2. Conductors shall be tested for water-blocked in accordance with ICEA T-31-610 “Test Method for Conducting Longitudinal Water Penetration Resistance Tests on Blocked Conductors”.
- E. The insulation system shall consist of a conductor stress control layer of conventional semi-conducting compound. For discharge resistant insulating compounds, a high dielectric constant, non-conducting compound may be used as a conductor stress control layer. The thickness of this layer shall be in accordance with Table 3-1 of ICEA S-94-649-13. The insulation thickness shall be 175 mils minimum average, 100% level for EPR. The insulation shield shall be a nonmetallic, semi-conducting compound. The thickness of this layer shall be in accordance with Table 5-1 of ICEA S-94-649-13. The nominal O.D. over the insulation shall be as specified in Table 2-10 of AEIC CS8-13.
- F. The insulation shield shall be strippable using conventional splicing tools without applying heat or use of special tools, without damaging the insulation or leaving any conducting material which cannot be easily removed. The insulation shielding

layer shall be legibly and permanently identified as being semiconducting and that it is to be removed at splices and terminations.

- G. A 5 mil tinned copper metallic shielding tape with a 12.5% overlap shall be helically applied over the extruded semi-conducting insulation shield. A 5 mil cured neoprene coated nylon fabric tape with a 10% overlap shall be helically applied over the metal tape shield.
- H. The neutral conductor shall be a bare 4/0 AWG, 19 strand, Class B bare copper (B8) cable. If approved by the Engineer, a bare 4/0 compact round cable per ASTM B-496-16 cable may be provided.
- I. The overall jacket shall be an insulating, black, linear low density polyethylene (LLDPE) compound in accordance with ANSI/ICEA S-94-649-2013, Part 7.1.1. The jacket shall be free stripping.
- J. 500 KCMIL cables shall consist of 37 strands of compact round phase conductors, 19 strand 4/0 AWG Neutral, with insulation diameter between 1125 and 1185 mils, a jacket thickness of 80 mils and an overall diameter of 3.28 inches.
- K. All cable shall be shipped on returnable steel reels. The arbor hole shall be nominal 5-1/4" to 5-1/2" in diameter. The two drive holes shall be 2-1/2" to 3" in diameter and on a radius of 11-1/2" to 13" from the center of the arbor hole. The trailing end of the cable shall not extend out of the dog hole. Maximum reel size shall not exceed 96" in overall diameter or 56" in overall width. 500 KCMIL cable shall be shipped with a maximum of 800 circuit feet per reel. All cable ends shall be permanently sealed against water ingress with a suitable cap. Pulling eyes are not required.
- L. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Okonite Company
 - 2. Kerite Co.
 - 3. Hubbell Incorporated.
 - 4. Prysmian Cables & Systems

5. Southwire.
 6. Or approved equal.
- M. Connectors and Splice Kits shall comply with IEEE 404 with the type as recommended by the cable or splicing kit manufacturer for the application. Splicing Products will be as recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions. Splices shall be suitable for submersible applications.
- N. In-Line Splices shall be heat-shrink splicing kit of uniform cross-section, polymeric construction with outer heat-shrink jacket that covers the entire splice. The grounding mesh shall be internal to the outer jacket. Connectors shall be compression type.
- O. Solid terminations for shielded cables shall comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations to be one of the following:
1. Class I Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
 2. Class I Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
 3. Class I Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
- P. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- Cable Splicing Products and Accessories:
1. Thomas & Betts Corporation/Elastimold, Part No. 655LR and K655LR power distribution connectors.
 2. TE Connectivity

3. Or approved equal.
- Q. 600-A dead break connectors, “hammerhead style,” with no test point shall be used for 15 KV high voltage splices in manholes. 600-A dead break connectors shall be supplied by Tyco/Ray-Chem or approved equal. Separable insulated connectors shall comply with IEEE 386.
- R. Provide tool set consisting of shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.
- S. Tape for first course on metal objects will be 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape. Arc-Proofing Tape to be used is fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket. Glass-cloth tape will be pressure-sensitive adhesive type, 1/2 inch wide.
- T. Fault indicators are automatically reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
- U. Test and inspect cables according to ICEA S-97-682, ICEA S-94-649 before shipping. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig. Obtain cables and accessories through one source from a single manufacturer.

Construction Methods:

- A. Install cables according to IEEE 576.
- B. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable. Before pulling cables in existing conduits, the Contractor shall review the conduit run via camera to verify that the conduit does not contain obstructions that could damage the cables. Obstructions shall be removed by thorough cleaning and then testing by the successful pulling of a brush and mandrel approved by the

Engineer. The mandrel shall be not less than ¼ inch smaller than the inside nominal diameter of the conduit. The Contractor shall give the Engineer 24 hours notice prior to witness the cleaning and testing.

- C. Install direct-buried cables on leveled and tamped bed of 3 inch thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices. Install "buried-cable" warning tape 12 inches above cables.
- D. In manholes, handholes pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag. Install cable splices at pull points and elsewhere as indicated; use standard kits. Install terminations at ends of conductors and seal cable ends with standard kits.
- E. Install separable insulated-connector components as follows:
 - 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 - 2. Portable Feed-Through Accessory: Three.
 - 3. Standoff Insulator: Three.
- F. Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc proofing tape manufacturer's written instructions, apply arc proofing as follows:
 - 1. Clean cable sheath.
 - 2. Wrap metallic cable components with 10-mil (250-micrometer) pipewrapping tape.
 - 3. Smooth surface contours with electrical insulation putty.
 - 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable. Band arc-proofing tape with 1-inch wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.

- G. Seal around cables passing through fire-rated elements with penetration Firestopping.
- H. Install fault indicators on each phase where indicated.
- I. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- J. Identify cables according to NFPA 70 and ANSI A13.1 "Identification for Electrical Systems." The insulating overall jacket of each cable shall be legibly and permanently indented throughout its length, on its outer surface, with the manufacturer's name and trademarks, type and thickness of insulation, rated voltage, conductor size, and year of manufacture. The manufacturer shall also mark the cable jacket throughout its length to indicate footage. The identification shall be repeated along the cable at intervals not exceeding 2" for the insulation shield and 6" for the jacket.
- K. Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports: Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
- L. Remove and replace malfunctioning units and retest as specified above.

Method of Measurement:

- A. The work covered by this section will be measured on a per "linear foot" basis for each conductor field assembled in the triplexed assembly, completely installed, including but not limited to materials, equipment, and labor for the installation, splicing, terminations and testing of the 15 KV Shielded Copper Cables.

Basis of Payment:

This work will be paid for at the contract unit price each for “500KCMIL, 15 KV SHIELDED COPPER CABLE.”

<u>Pay Item</u>	<u>Pay Unit</u>
500KCMIL, 15 KV Shielded Copper Cable	L.F.

ITEM #0001137A – 35 KV COPPER WIRE NO. 1/0 AWG
ITEM #0001139A – 750KCMIL, 35 KV SHIELDED COPPER CABLE

Description:

Scope

This applies to 133% insulated thermosetting ethylene propylene rubber (EPR) shielded and jacketed cable rated 35kV phase-to-phase for use on single-phase 60-hertz systems. The cables shall be suitable for installation in wet or dry environments and direct buried or in conduit for operation at a maximum normal conductor temperature of 90°C, emergency overload temperature of 130°C and short circuit temperature of 250°C. The cables shall be designed for and warranted in writing for 40 years of installed energized operation.

Applicable Standards

Pertinent provisions of the following listed standards shall apply to the work of this Section, except as they may be modified herein, and are hereby made a part of this specification to the extent required.

<u>Organization</u>	<u>Number</u>	<u>Title</u>
AEIC	CS6	Specification for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69kV
ASTM	B 8	Standard Specification for Concentric-Lay- Stranded Copper Conductors, Hard, Medium- Hard, Soft
ICEA/NEMA	ICEA S-95-658/WC 70	Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
ICEA/NEMA	S-93-639/WC 74	Shielded Power Cable 5-46 kV
IEEE	48	IEEE Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations
IEEE	C2	National Electrical Safety Code
NEMA	WC 26	Wire and Cable Packaging
NFPA	70	National Electrical Code
UL	44	Standard for Safety, Thermoset-Insulated Wires and Cables

UL

1072

Standard for Safety, Medium-Voltage Power

Quality Assurance

- A. Cable Manufacturers' Qualification: Shall have not less than fifteen (15) years' experience in the actual production of the specified products.
- B. Workmanship shall conform to the best modern practices in the manufacturing of a rugged, durable, and safe product for use in a public transportation system. Materials used shall be new and of the highest commercial grade as specified.
- C. The Insulated Cable shall be manufactured and tested under the control of a Quality Assurance system that conforms to the requirements of ISO 9000.
- D. The Quality Assurance system shall demonstrate conformance to the above criteria by having passed yearly quality audits conducted by outside independent organizations.
- E. Information regarding the manufacturer's Quality Program shall be furnished to the Engineer and United Illuminating upon request.
- F. Cable shall meet United Illuminating (UI) – Electric Systems Distribution Equipment Specifications for “4CT, 15KV and 35KV 1/0, 4/0, 500&750 Compact Round Copper Insulated, Jacketed Cable.

Submittals

The Contractor shall submit the following for review and approval of the designer at various stages of planning, manufacturing, and installation of cable and wire as requested:

- A. Descriptive literature, catalog data, and other pertinent information for cable splices sufficient to clearly demonstrate compliance with the Contract Documents.
- B. Cable pulling plan showing cable feed and pulling winch locations, cable lengths, and calculated pulling tensions for each cable pull over 200 feet in length, or with a total of 180° or more of conduit bends.
- C. Proposed cable lubricants and associated lubricating devices.
- D. Proposed cable pulling equipment including cable grips, pulling rope, tension-meters, swivels, and cable pullers (winches).
- E. Qualifications of all cable splicers proposed to be utilized for splicing work.

- F. As-built lengths of all cable installed under this Contract.
- G. Product Data: Shall consist of manufacturer's standard catalog cuts, descriptive literature and diagrams, in 8½ X 11-inch format, and in sufficient detail so as to clearly indicate compliance with all specified requirements and standards.
- H. Manufacturer's Certification: Manufacturer shall submit signed certification confirming that they comply with the qualifications requirements and shall provide evidence of experience upon request.
- I. Product Certification: Signed by manufacturer certifying that products comply with the specified specification requirements.
- J. Report of Field Tests: Certified copies of field tests.
- K. 24-inch long samples of the final assembled cables for First Article Inspection prior to release.
- L. Submit catalog cuts for the following:
 - a. Wires and cables for each type and size,
 - b. Splice kit materials and installation procedures
 - c. Physical Characteristics and Parameters:
 - i. Size
 - ii. Type and class
 - iii. Materials (Insulation and Jacketing)
 - iv. Number of and diameter of individual wires
 - v. Overall diameter
 - vi. Cross section area
 - vii. Weight per foot
 - viii. Maximum pulling tension
 - ix. Minimum bending radius for pulling and training
 - x. Maximum sidewall pressure
 - d. Electrical Characteristics:
 - i. Conductor size (AWG/kcmil)
 - ii. Resistance per unit length
 - iii. Details of metallic shield design
 - e. Design and production test plan, test procedures and certified test reports. The Contractor shall submit cable rack installation work plans for manholes and vaults for approval. It is of the utmost importance that very low resistance electrical contact is made at the points of connection of each cable; therefore, only the best and most highly

skilled cable splicers shall be employed. All connections shall have a conductivity and insulation resistance at least equal to that of the cable. Splicers shall have a minimum of five years' experience in splicing and terminating 35kV and 600V cables of the type and size(s) involved under similar conditions. Prior to making of pothead, or stress cone termination, the Contractor shall submit to the Engineer, for approval, the name of each individual who will perform this type of work including the background of each such individual on similar previous projects. Each splicer shall be certified by the Engineer. MNR may request the splicer to make a test termination in the presence of the Engineer before the approval is granted.

M. Submit certified shop test reports for wires and cables.

N. Submit field test results for wires and cables, including megger readings with the method used.

Materials:

- A. Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Cable construction standards, definitions of terms and conductor insulation shall be in strict accordance with applicable publications of ICEA and NEMA for the cable provided. Insulated cables shall have Class B or C stranding as noted. Conductors for insulated cables shall be copper.
- C. Insulated Trolley and Feeder Cable - 35kV, 133 percent insulation level, 1/0 AWG, 500 kcmil and 750 kcmil copper cables for the 13.2kV, 60Hz traction power system shall be, low-smoke, ozone resistant, ethylene-propylene rubber-insulated power cable conforming to ICEA/NEMA S-93-639/WC 74. Cable shall be single conductor; employing concentric Class B stranded copper conductor. Cable shall have conductor and insulation shielding. The insulation shield shall include non-magnetic metal tape or wire strands applied over or embedded in the non-metallic covering. The metallic shield shall be designed to carry the maximum ground fault current of 25kA. The cable shall be rated at 90 degrees C operating temperature and 130 degrees C hot-spot temperature. Cable rated higher than 90 degrees C cannot be used in standard PVC conduit. The cable jacket shall be an extra heavy-duty compound meeting the requirements of ICEA/NEMA S-93-639/WC 74, Section 7. The cables shall be able to withstand frequent over voltages, switching surges, harmonics, highly fluctuating loads and short circuits, normally encountered daily in traction power systems.
- D. Finished cables shall pass partial discharge test specified in AEIC CS6 and shall meet UL 1072. The cables shall be guaranteed against failure due to workmanship and materials for a period of at least five years from the date of final commissioning. The following information shall be printed on the jacket, using contrasting color ink, at not more than 2' intervals:
 - a. Manufacturer's name

- b. Temperature rating
 - c. Conductor size
 - d. Year of manufacture
 - e. Insulation type and thickness
 - f. Voltage rating
 - g. Jacket type and thickness
 - h. UL listing
- E. High-voltage Termination – High-voltage outdoor terminations shall have a voltage class rating equal to or greater than the cable being terminated. The rating shall be 25/28 kV for the signal power cable and 35 kV for the traction power cable and both shall be Class 1 terminations in accordance with IEEE standard 48-2009. It must have a maximum continuous operating temperature rating of 105° C, with an emergency overload rating of 140° C. The termination stress control shall be capacitive and constructed of a Hi-K stress control compound and a Hi-K EPDM rubber tube. The installation procedure shall not require using silicone grease. The termination insulator shall be skirted design, constructed of tracking resistant silicone rubber, dark gray in color. The termination must be of a prestretched cold stretched design, installed without the application of a heat source. The termination kit shall include all material required (except lug) and shall accommodate tape, wire or Unishield® shielded cables. The termination kit shall be 3M™ Cold Shrink Silicone Rubber Termination Kit QT-III 7680-S Series or an approved equal. Splicing of high-voltage cable will not be permitted.
- F. Reels and Packing
- a. The cable shall be packaged, furnished and shipped on returnable reels in accordance with NEMA Standard WC 26. Reels shall be constructed of materials, which shall provide protection to the cable during shipment and handling. A watertight seal shall be applied to each end of the cable to prevent the entrance of moisture during transit or outdoor storage. A durable label shall be securely attached to each flange of each reel. Each label shall indicate the purchase order number, name of manufacturer, reel number, length of cable on reel, description of cable, weight of reel, rolling direction, and source of manufacture.
- G. All cables shall comply with AEIC CS8-13, Specification for Extruded Dielectric Shielded Power Cables, Rated 5 through 46kV and ANSI/ICEA S-97-682-2013, Standard for Utility Shielded Power Cables Rates 5,000 – 46,000 volts, with options as detailed.
- H. It shall be the responsibility of the manufacturer to insure compatibility among all components of the cable.
- I. The conductors shall be uncoated copper, compact round strand in accordance with ASTM Specification B496-16, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors. The conductors shall be sealed from water intrusion in accordance with ICEA S-94-649-2016, Part 2.2. Conductors shall be tested for water-blocked in accordance with ICEA T-31-610 “Test Method for Conducting Longitudinal Water Penetration Resistance Tests on Blocked Conductors”.

- J. The insulation system shall consist of a conductor stress control layer of conventional semi-conducting compound. For discharge resistant insulating compounds, a high dielectric constant, non-conducting compound may be used as a conductor stress control layer. The thickness of this layer shall be in accordance with Table 3-1 of ICEA S-94-649-13. The insulation thickness shall be 420 mils minimum average, 133% level for EPR. The insulation shield shall be a nonmetallic, semi-conducting compound. The thickness of this layer shall be in accordance with Table 5-1 of ICEA S-94-649-13. The nominal O.D. over the insulation shall be as specified in Table 2-10 of AEIC CS8-13.
- K. The insulation shield shall be strippable using conventional splicing tools without applying heat or use of special tools, without damaging the insulation or leaving any conducting material which cannot be easily removed. The insulation shielding layer shall be legibly and permanently identified as being semiconducting and that it is to be removed at splices and terminations.
- L. A 5 mil tinned copper metallic shielding tape with a 12.5% overlap shall be helically applied over the extruded semi-conducting insulation shield. A 5 mil cured neoprene coated nylon fabric tape with a 10% overlap shall be helically applied over the metal tape shield.
- M. The neutral conductor shall be a bare 4/0 AWG, 19 strand, Class B bare copper (B8) cable. If approved by the Engineer, a bare 4/0 compact round cable per ASTM B-496-16 cable may be provided.
- N. The overall jacket shall be an insulating, black, linear low density polyethylene (LLDPE) compound in accordance with ANSI/ICEA S-94-649-2013, Part 7.1.1. The jacket shall be free stripping.
- O. 750 KCMIL cables shall consist of 61 strands of compact round phase conductors, 19 strand 4/0 AWG Neutral, with insulation diameter between 1125 and 1185 mils, a jacket thickness of 80 mils and an overall diameter of 3.47 inches.
- P. All cable shall be shipped on returnable steel reels. The arbor hole shall be nominal 5-1/4" to 5-1/2" in diameter. The two drive holes shall be 2-1/2" to 3" in diameter and on a radius of 11-1/2" to 13" from the center of the arbor hole. The trailing end of the cable shall not extend out of the dog hole. Maximum reel size shall not exceed 96" in overall diameter or 56" in overall width. 500 KCMIL cable shall be shipped with a maximum of 800 circuit feet per reel. All cable ends shall be permanently sealed against water ingress with a suitable cap. Pulling eyes are not required.
- Q. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Okonite Company
 - b. Kerite Co.
 - c. Hubbell Incorporated.
 - d. Prysmian Cables & Systems
 - e. Southwire.
 - f. Or approved equal.
- R. Connectors and Splice Kits shall comply with IEEE 404 with the type as recommended by the cable or splicing kit manufacturer for the application. Splicing Products will be as recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors.
- i. Include all components required for complete splice, with detailed instructions. Splices shall be suitable for submersible applications.
- S. In-Line Splices shall be heat-shrink splicing kit of uniform cross-section, polymeric construction with outer heat-shrink jacket that covers the entire splice. The grounding mesh shall be internal to the outer jacket. Connectors shall be compression type.
- T. Solid terminations for shielded cables shall comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations to be one of the following:
- a. Class I Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
 - b. Class I Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
 - c. Class I Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
- U. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- i. Cable Splicing Products and Accessories:

- b. Thomas & Betts Corporation/Elastimold, Part No. 655LR and K655LR power distribution connectors.
 - c. TE Connectivity
 - d. Or approved equal.
- V. 600-A dead break connectors, “hammerhead style,” with no test point shall be used for 15 KV high voltage splices in manholes. 600-A dead break connectors shall be supplied by Tyco/Ray-Chem or approved equal. Separable insulated connectors shall comply with IEEE 386.
- W. Provide tool set consisting of shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.
- X. Tape for first course on metal objects will be 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape. Arc-Proofing Tape to be used is fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket. Glass-cloth tape will be pressure-sensitive adhesive type, 1/2 inch wide.
- Y. Fault indicators are automatically reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
- Z. Test and inspect cables according to ICEA S-97-682, ICEA S-94-649 before shipping. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig. Obtain cables and accessories through one source from a single manufacturer.

Construction Methods:

- A. Install cables according to IEEE 576.
- B. Insulated cables shall be installed by the Contractor in underground ducts, conduits, pullboxes, manholes, and aboveground feeder risers and conduits as shown on the plans. Prior to pulling cables of this section, the Contractor shall perform pulling calculations to determine the direction of pull, and maximum expected pulling tensions based on setup, length of pull, number of bends and pull points. These calculations shall be submitted to the Engineer for review at least 45 days prior to intended pull. Any deficiencies in the calculation shall be resolved prior to work being performed. A pulling tension calculation shall be provided for each cable pulled. Care shall be exercised in pulling cables in conduit to avoid kinking, putting undue stress on the cable, compressing, and distorting or otherwise abrading cable insulation. A lubricating compound shall be used while pulling cables. Cable pulling tension and cable sidewall pressure applied during the

pulling process shall not exceed the manufacturer's published recommendations. Rollers, jams and quadrant blocks shall be utilized as required to facilitate cable installation. A dynamometer shall be used for all pulls. The dynamometer shall be calibrated by Contractor and verified by the Engineer prior to pulling cables. Care shall be exercised in preventing access of water and vermin into the cable vault/manhole by sealing the cable entrances. Cable rack and support mounting bolts shall be installed by inserting the bolt into a field-drilled hole on the concrete wall or floor. The voids of the hole shall be filled with non-shrink resin grout. The locations of the cable racks in manholes and hand holes shall not conflict with knockout panels. The positions of the rack shall be arranged in an orderly manner with approximately two-foot separation. The quantity of mounting bolts for the vault cable supports shall be sufficient to provide for stable cable installation. Cables in the cable vaults and manholes shall be supported in accordance with the manufacturer's recommendations to prevent damage due to their weight and forces present during faults. Splices, where required, shall be supported on both sides of the joint. All cables and splice supports shall be furnished and installed by the Contractor. The cables in the vaults and manholes shall be tagged every 20 feet and fire proofed. The details of the fireproofing shall be subject to the approval of the Engineer. Terminations of insulated power cables shall be protected from accidental contact, deterioration of coverings, and moisture, by the use of terminating devices and materials. Terminations shall be made using materials and methods as indicated or specified herein, or as designated by the written instruction of the cable manufacturer and termination kit manufacturer. Terminations shall be rated and be capable of withstanding test voltages in accordance with the IEEE 48. Terminations of single cables shall include the securing and sealing of the sheath and insulation of the cable conductors, stress relief, and grounding of cable shields of shielded cable. Cables and cable terminations shall be adequately supported so as to avoid any excessive strain on the termination and the conductor connection and to prevent exceeding minimum manufacturer recommended bend radius. Contractor shall terminate all power cables on cable connection pad in to the substation enclosure and insulate in accordance with manufacturer requirements.

- C. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable. Before pulling cables in existing conduits, the Contractor shall review the conduit run via camera to verify that the conduit does not contain obstructions that could damage the cables. Obstructions shall be removed by thorough cleaning and then testing by the successful pulling of a brush and mandrel approved by the Engineer. The mandrel shall be not less than ¼ inch smaller than the inside nominal diameter of the conduit. The Contractor shall give the Engineer 24 hours notice prior to witness the cleaning and testing.
- D. Install direct-buried cables on leveled and tamped bed of 3 inch thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices. Install "buried-cable" warning tape 12 inches above cables.

- E. In manholes, handholes pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag. Install cable splices at pull points and elsewhere as indicated; use standard kits. Install terminations at ends of conductors and seal cable ends with standard kits. Install cable convertor where two insulated cables convert to bare copper cable and seal cable ends with standard cable convertor kits.

- F. Install separable insulated-connector components as follows:
 - a. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.

 - b. Portable Feed-Through Accessory: Three.

 - c. Standoff Insulator: Three.

- G. Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc proofing tape manufacturer's written instructions, apply arc proofing and fire proofing as follows:
 - a. Clean cable sheath.

 - b. Wrap metallic cable components with 10-mil (250-micrometer) pipewrapping tape.

 - c. Smooth surface contours with electrical insulation putty.

 - d. Apply arc-proofing tape in one half-lapped layer with coated side toward cable. Band arc-proofing tape with 1-inch wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.

 - e. Use 53 Plyarc by Plymouth or approved equal arc proofing and fire proofing tape

- H. Seal around cables passing through fire-rated elements with penetration Firestopping.

- I. Install fault indicators on each phase where indicated.

- J. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

- K. Identify cables according to NFPA 70 and ANSI A13.1 "Identification for Electrical Systems." The insulating overall jacket of each cable shall be legibly and permanently

indented throughout its length, on its outer surface, with the manufacturer's name and trademarks, type and thickness of insulation, rated voltage, conductor size, and year of manufacture. The manufacturer shall also mark the cable jacket throughout its length to indicate footage. The identification shall be repeated along the cable at intervals not exceeding 2" for the insulation shield and 6" for the jacket.

L. Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports: Perform the following field tests and inspections and prepare test reports:

- a. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
- b. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

M. Remove and replace malfunctioning units and retest as specified above.

Method of Measurement:

- A. The quantity of 35 KV copper wire No. 1/0 will be measured for payment by the actual number of linear feet completely installed and accepted, including but not limited to materials, equipment, and labor for the installation, cable conversion, terminations and testing of the 35 KV Shielded Copper Cables.
- B. 750 KCMIL, 35 KV Shielded Copper Cable is measured under Item #0090074A Traction Power Distribution System.

Basis of Payment:

The 35kV Copper wire No. 1/0 AWG will be paid for at the contract unit price for linear foot installed and accepted. There will be no separate payment for use of cable pullers, rollers, blocks, dynamometer (including calibrations) or other equipment and tools necessary for pulling cable, but the cost thereof shall be covered under this item.

750 KCMIL, 35 KV Shielded Copper Cable is not paid for separately but included and paid for under Item #0090074A Traction Power Distribution System.

Pay Item

Pay Unit

35KV COPPER WIRE NO. 1/0 AWG

L.F

ITEM #0090042A - CATENARY SYSTEMS

ITEM #0090045A - AERIAL GROUND WIRE SYSTEMS

ITEM #0090074A – TRACTION POWER DISTRIBUTION SYSTEM

Description:

Scope

- A. The work of this Section specifies the application design, furnishing, installation, testing and placing into service the catenary, traction power feeder and ground wire systems required for the new and replacement facilities. This includes all temporary and permanent modifications to support and fully execute the staged construction.
- B. The individual systems as shown in the Contract Drawings and described herein, comprise the conductors complete with insulated and non-insulated supporting assemblies, hangers, jumpers, sectionalizing assemblies, termination assemblies, crossing wire arrangements and all connectors, splices, in-span components, hardware and all other fittings and miscellaneous steel assemblies necessary to complete and place into service each wire run, as indicated in the Contract Drawings and in any supplemental approved construction plans prepared by the Contractor.
- C. The Contractors work also includes coordination with the MNR for necessary outages for performing the work and for any catenary, power distribution, or grounding systems work to be performed by MNR forces at the project segment interfaces, as required to accomplish the construction work and place the systems in operation. The Contractors work also includes coordination with other Contractors performing work within the project area.
- D. The Contractor is alerted to the constraints imposed on installation of the catenary system due to the necessity for maintaining revenue railroad operations. Installation, adjustment and pre-operation inspections of the constructed segments shall be performed within the periods of agreed line outages, or other times as agreed by the MNR.
- E. Insulators:
 - 1. The design, manufacture, and supply of insulators for the catenary and traction power systems, including, but not limited to suspension, strain, and stand-off insulators, as shown on the Contract Plans and specified herein.
 - 2. Insulators shall be incorporated into support, registration, termination and “in-span” and other assemblies comprising the Catenary and Traction Power Systems as shown on the plans and specified herein.
- F. Grounding and Bonding Systems:
 - 1. The design, furnishing, installing and testing of the grounding and bonding systems for the electric traction system, as depicted in the contract Documents and specified herein.

2. Grounding and bonding of electric traction facilities includes, but is not limited to:
 - a. Bonding new and modified existing catenary steelwork to the aerial ground wire and/or ground wire as shown on the plans.
 - b. Bonding and grounding of personnel ground mats to earth, disconnect switch operating rods and disconnect switch supporting steel at all disconnect switch locations as shown on the plans.
3. The work also includes the application design, furnishing, installing and testing of temporary grounding and bonding systems required to connect temporary supporting steelwork installed by the Contractor for his staging work.

G. Fittings and Hardware:

1. This Section covers the design, manufacture and supply of ferrous and non-ferrous metal material, hardware and fittings for use individually, and in the various assemblies comprising the catenary systems, traction power supply systems, aerial ground wire systems and grounding and bonding systems.
2. The Contractor is advised that high-strength alloy shackles and turnbuckles are specified and to be furnished on this Project. The Contractor is responsible for insuring that these high-strength alloy shackles and turnbuckles are furnished and installed in the Project work as per plans and specifications. The procurement and correct use of non-alloy turnbuckles and shackles shall also be the responsibility of the Contractor.
3. The work includes but is not limited to the following:
 - Hanger assemblies
 - Wire crossing assembly
 - Clevis - tongue fittings
 - Clevis-clevis fittings
 - Parallel wire clamps
 - Nuts, bolts, washers, keys and cotter pins
 - Shackles Links and eyebolts
 - Messenger, contact and span, wire terminations and turnbuckles
 - Double clevis end fittings
 - Thimbles
 - Wire sleeves
 - Wire splices
 - Messenger suspension clamps and span wire supports
 - Span wire clamps, trunnion clamps
 - Wire connectors
 - Full tension compression joint fittings
 - Strain clamps
 - Wire knuckles

- Anti-torsion pipe hangers
- Service connectors
- Cross arms
- Cable crossing in conduit assembly
- Terminator assembly
- Jumper cable assembly
- Pin insulator assembly
- Switching assembly
- Pole reinforcement

H. Catenary Assemblies:

1. Work under these items covers the manufacture, supply and installation of the following types of catenary support and registration assemblies.
 - Pull-off and push-off cantilevers - all types for one or more catenaries
 - Two track cantilevers for one or more catenaries
 - Multi-track cross-catenary and cross-span support and registration assemblies
 - Multi-track steady wire registration assemblies
 - Cross-catenary assemblies
 - Wire pull-off registration assemblies for one or more catenaries
 - Termination assemblies
2. The Contractor shall design, manufacture, supply, fabricate and install all assemblies as indicated on the Contract Plans, as necessary to provide a complete, reliable and safe system.

I. Stainless Steel Wire Rope and Rods:

1. This Specification covers the supply of stainless steel wire rope and rod as shown on the Contract Plans. The work includes, but is not limited to, the following:
 - Cantilever nose hangers
 - Stainless steel catenary hangers
 - Supporting rods for signage

J. Uninsulated Wires:

1. This Specification covers the supply of uninsulated wires as shown on the plans. The work includes, but is not limited to, the following:
 - Messenger Wires
 - Contact Wires
 - Catenary Jumper Wires
 - Traction Power Aerial Feeder and Jumper Wires
 - Aerial Ground Wires
 - Cross Span Wires
 - Pull-Off Wires
 - Steady Wires

2. Supply all applicable bare conductors and wires for the new electric traction facilities in accordance with the requirements specified in the Contract Plans and these Technical Specifications.

Related Sections, Notices and References

A. Related Bid Item Sections:

High Speed Section Insulators
Guy Assemblies
Modifications and Additions to Existing Catenary Systems
Disconnect Switch and Sectionalizing Jumper Taps
Inspection and Testing

B. References:

1. The Contract Drawings and pertinent provisions of all applicable Codes and Standards, as referenced in other Sections of the Specifications, shall apply to the work of this Section, and are hereby made a part of this Specification to the extent required.
2. If other types of materials are proposed, the Contractor shall, along with the product description, submit the relevant standards and information on that material for approval of the Engineer.

Meetings & Coordination

- A. Conduct a Pre-Installation Meeting at the Project Site in compliance with the requirements of Standard Specifications.
- B. The Contractor shall coordinate the work with the Engineer, the work of other Contractors, and rail operators including but not limited to MNR & AMTRAK within the New Haven Rail Yard to ensure no interference to train operations, other than work planned.

Submittals

A. Catenary Assemblies:

1. At least forty five (45) days prior to commencing the installation work, the Contractor shall submit for review, a Systems Installation Plan. This plan shall indicate the sequence, methods, procedures and permanent and temporary materials and equipment proposed for construction and pre-revenue operation inspections of each element of the individual systems to be built. The plan shall contain sufficient detail to allow assessment by the MNR.

- B. The Installation Plan shall demonstrate maintenance of operations and compliance with the railroad's requirements for work over or adjacent to the railroad.

- C. The Contractor shall prepare and submit completely detailed allocation drawings, component shop drawings, assembly and sub-assembly drawings and required certification for all Contractor-furnished components for each system, based on designs shown in the Contract Drawings and MNR's approved Standards for Electric Traction Facilities. Any deviation from these criteria, or supplements thereto, shall be submitted for approval of the Engineer. Fabrication of components shall not proceed until the shop drawings have been reviewed and approved by the Engineer.
- D. The Contractor shall revise or submit supplemental details of the Systems Installation Plan, as requested by the Engineer.
- E. The Contractor shall submit a Testing Plan as per Catenary Assemblies, for approval of the Engineer.
- F. Provide sufficient detail and clarity so that the work can be properly controlled and interfaced, and the Engineer can readily monitor and follow progress for all portions of the work. The Contractor shall comply with the various limits imposed by the construction staging and by any contractually specified milestone and completion dates. Limit activity durations to achieve the milestones as agreed. The degree of detail shall be to the satisfaction of the designer.
- G. The Contractor shall be responsible for the safe and successful construction of the work. Construction Drawings requiring original design which is the responsibility of the Contractor, shall bear the seal of a professional engineer registered in the State of Connecticut who was in responsible charge of the design.
- H. All submittals shall be made sufficiently in advance of the fabrication associated with the temporary and permanent construction, to permit review by the designer.
- I. If drawings show variations from the Contract requirements for any reason, describe such variations in the letter of transmittal. If acceptable, the designer may approve any or all such variations, subject to a proper adjustment in the Contract. If the Contractor fails to describe such variations he shall not be relieved of the responsibility for executing the work in accordance with the Contract, even though such drawings have been accepted. Drawings or schedules submitted showing minor departures from the Contract requirements which do not involve a change in the Contract price or time for performance may be accepted at the discretion of the designer.
- J. Insulators:
 - 1. For Insulators, Manufacturer's certification shall be provided showing compliance with the applicable requirements of the referenced Standards, these Specifications and the Contract Plans, as follows:
 - i. Steel analysis
 - ii. Hot dip galvanizing

- iii. Adhesive materials
 - iv. Insulator materials
 - v. In-service record of proposed insulators
 - vi. Certified quality control procedures used in the manufacturing process.
2. Insulator Shop Drawings: Shop Drawings shall be submitted prior to procurement and fabrication. Included, as a minimum, shall be:
- a. Electrical:
 - Creepage length (inches)
 - Insulation level (impulse withstand test voltage, kV).
 - Maximum working voltage (kV)
 - b. Mechanical:
 - Attachment centers or overall length (inches).
 - Shed diameters (inches).
 - Core diameters (inches).
 - Breakdown of weights, insulator and fittings (pounds).
 - Tensile withstand load (pounds).
 - Tensioned strength (pounds).
 - Cantilever withstand load (pound-inches).
 - Recommended Maximum working tensile load (inch-pounds).
 - Recommended Maximum working cantilever load (inch-pounds).
 - Material (including end caps and touch-up insulator sealants).
 - c. Manufacturer's design mechanical and electrical safety factors.
 - d. Drawings of hardware and components.
 - e. Listing and description of components and hardware.
 - f. Weights (including weight of components).
 - g. Storage and handling instructions.
3. Factory Test Reports

K. Grounding and Bonding Systems:

- 1. Reports of all field tests shall be submitted to the Engineer as required by these Specifications and referenced standards.
- 2. The Contractor shall submit product data including test results and relevant drawings for all components proposed for use in the work of this Section.

3. Submit samples of mechanical and compression grounding connectors and indicate the intended application.

L. Fittings and Hardware:

1. Submit shop drawings for all components for approval prior to ordering or fabrication showing details and dimensions, and giving designations of the materials comprising the various components together with technical, mechanical and electrical characteristics as appropriate. Also submit details of the manufacturing methods and quality assurance and inspection procedures.
2. Samples of certain components shall be submitted, including: hanger assemblies, wire crossing assembly, clevis-tongue fittings, clevis-clevis fittings, parallel wire clamps, thimbles, wire splices, wire connectors and full tension compression joint fittings. Samples of other items shall be submitted as may be directed by the Engineer.

M. Catenary Assemblies:

1. Within forty days of notice to proceed, a complete package of application design calculations, installation sequence, field measurements of existing structures, and component shop drawings and catalog cuts shall be assembled by the Contractor, for each type of catenary assembly, supporting device and associated attachments. This package shall be submitted to the Engineer for review and acceptance.
2. Furnish a certification verifying that all material included in the assemblies has been manufactured, inspected and tested in accordance with the referenced standards and these specifications.
3. The Engineer reserves the right to check and inspect the manufacture, testing and quality control procedures at any time.
4. Furnish complete manufacturer's data and drawings. Furnish calculations for the design of each component to demonstrate adequate load capacity of each item in the configuration.

N. Stainless Steel Wire Ropes and Rods:

1. Certification: Furnish certification verifying that the stainless steel wire rope, and rod have been designed, manufactured, inspected and tested in accordance with the referenced standards and these Specifications.
2. Test Reports: Furnish copies of reports of all factory tests as required by these Specifications and referenced standards.
3. Manufacturer's Data: Furnish complete manufacturer's data and relevant drawings.

O. Uninsulated Wires:

1. Submit product data and relevant drawings for approval prior to wire manufacture. Included as a minimum shall be:
 - i. Physical Characteristics and Parameters:
 - ii. Size
 - iii. Type
 - iv. Material
 - v. Number of and diameter of individual wires
 - vi. Overall diameter
 - vii. Cross section area
 - viii. Weight per foot
 - ix. Rated breaking load.
2. Electrical Characteristics:
 - i. Rated current carrying size (AWG/Kcmil)
 - ii. Resistance per unit length
3. Provide samples of conductors, as requested by the Engineer.
4. Furnish certification from the manufacturer verifying that the conductors have been designed, manufactured, inspected and tested in accordance with applicable portions of the referenced standards, these Specifications, and the plans.
5. Provide certified copies of manufacturer's test reports for the specific conductors furnished, which shall include but not limited to the following:
 - i. Initial and Final Modulus of Elasticity
 - ii. Coefficient of Thermal Expansion
 - iii. Yield stress
 - iv. Hardness values
 - v. Contact wire joint strength test.

Quality Assurance

- A. The Contractor shall submit to the Engineer, on request, evidence confirming the qualifications of the person responsible for installation of the Catenary, Power Distribution and Grounding and Bonding Systems. Such confirmation shall indicate successful completion of at least three (3) similar transit overhead projects, and references shall be furnished.
- B. Fittings and Hardware:
 1. For tension tests, a minimum of three test bars shall be poured from each lot of metal.
 2. For chemical analysis each lot of castings shall be analyzed for conformance with the chemical composition specified in the referenced ASTM Standards.

3. A lot shall consist of all castings produced from a furnace melt.

Materials:

A. Catenary Assemblies:

1. The Contractor shall furnish all conductors, insulators, spans, guys and all other components, miscellaneous steel assemblies and materials necessary to complete the work to the satisfaction of the Engineer, in accordance with the Contract Drawings, this Specification and the agreed Construction Schedule.
2. No previously used materials shall be used for construction under this contract unless otherwise specified by the Engineer.

B. Insulator Materials:

1. General:

- a. Insulators shall have a minimum in-service life expectancy of 30 years under normal operating conditions.
- b. The insulators shall be designed to suit the various assembly arrangements, as shown on the plans.
- c. Insulators shall be unconditionally guaranteed by the manufacturer and/or supplier to be free from defects for a period not less than 5 years.
- d. The mechanical strength of insulators shall meet or exceed the strength indicated on the plans. Where the strength is not indicated, insulators shall exceed the ultimate strength of the conductor or guy to which it is attached.
- e. Insulators for various uses shall have ratings not lower than the classes indicated on the plans.
- f. Types and suggested electrical classes and minimum mechanical characteristics for OCS insulators shall conform to the plans. The overall length of the insulators shall conform to the plans for standardization.
- g. Each insulator shall bear the manufacturer's name, mark number and year of manufacture, clearly and permanently imprinted without affecting the appearance or the function of the item. The insulators shall be supplied complete with hardware, etc. as indicated on the plans.
- h. The insulators shall be designed for the class of insulation specified on the plans for the specific application and operating and environmental conditions.

- i. The insulators shall have the following minimum classifications, characteristics and ratings:

Characteristic	Catenary System*	Traction Power System*	
		Pin Type	Station Post Type
Insulator Class	25kV	34.5kV	34.5kV
Creepage Distance (minimum)	24"	21"	37"
Wet Flashover	60kV	80kV	80kV
Impulse Withstand	150kV	200kV	200kV

**Catenary insulators include but are not limited to suspension, strain, and stand-off insulators.*

2. Cantilevers:

- a. Catenary cantilever pipe support insulators shall be made of the best commercial-grade wet-process porcelain, in accordance with ASTM D116.
- b. The entire porcelain surface of the insulators that will be exposed after assembly shall be glazed in No. 70 light gray color as specified in ASME B16.11
- c. The surface shall be free of imperfections. Pieces with imperfections in the glaze repaired by refloating and refiring, as well as those pieces repaired by re-touching with paint, will be rejected.
- d. Cement used for assembling porcelain to metal shall meet or exceed the requirements of ASTM C150 and C151.

3. Non-ceramic insulators shall be used for all other applications:

- a. The non-ceramic insulator shall be a unit consisting of a rod, weathersheds as required, and end fittings. The rod shall be made of glass fiber or reinforced polymer (silicon, rubber, teflon, or cycloalipathic resin), with its fibers running longitudinally through the rod length. The rod may be attached to the end fittings or hardware by a compression sleeve, wedge or adhesive. If adhesive is used, the adhesive shall encapsulate the rod in the end-fitting cavity and shall form a compressive wedge upon loading. Weathersheds shall, for the expected life of the insulator, protect the rod from the elements and insure the necessary leakage distance.
- b. The non-ceramic insulator shall be constructed so as to be a light-weight, compact unit with high-impact strength. Weathersheds shall be "self-cleaning" and weather resistant to reduce the possibility of ice-bridging between sheds. They shall be of a

- material that is vandal resistant insofar as being shatterproof, thereby reducing vandalism damage.
- c. All non-ceramic material shall have a smooth, void-free finish. All adhesive coatings shall be sealed to the fittings to protect them against the ingress of moisture.
 - d. The design shall be such that stress due to temperature variation, and mechanical extension/contraction in any part of the insulator under load and normal handling, shall not lead to deterioration. The materials used shall not cause degradation by chemical interactions.
 - e. The end fittings attached to the insulator's fiberglass rod shall ensure exact alignment with the rod and correct assembly in respect to each other to avoid torsional stress when the insulator is installed.
 - f. The insulators shall be so designed that no sparking or arcing shall occur on the surface on the insulator when energized at the maximum design voltage under clean and dry conditions.
 - g. The contact wire non-riding insulators shall be used for the horizontal insulation of the grooved contact wire as cut-in tension member for insulated overlap spans. These shall be manufactured from the glass fiber reinforced resin without weather-sheds.
 - h. The metal parts of the insulators shall be made of malleable iron, Grade 35018, to conform with ASTM A47, or open-hearth or electric furnace steel. All ferrous metal parts shall be galvanized in accordance with ASTM A153. Insulator fittings shall provide for connections as shown on the plans.
 - i. To protect the galvanizing from harmful chemical action of the cement, the hardware which is in contact with cement shall be coated with a bituminous paint, or shall be as recommended by the insulator manufacturer for use with his materials.

C. Grounding and Bonding Systems:

- 1. Conductors for grounding and bonding shall be ASTM B8, Class B stranded annealed copper, and sized as indicated on the plans. Grounding cable from aerial ground wire to ground rod shall be 4/0 copper, and fastened with straps (Ransom type or approved equal) to the pole.
- 2. Connectors and Clamps: Bolts, washers and stop nuts shall be of high-copper alloy, Everdur, Durium, Duronze or silicone bronze. Ferrous hardware will not be acceptable.

D. Fittings and Hardware:

- 1. The identification mark of the manufacturer or foundry and the pattern numbers assigned by the supplier shall be cast into all castings. Marks and numbers shall be readable size, and in such a position that they will not affect the electrical or mechanical performance.

2. Material for hardware and fittings shall comply with the applicable referenced standards. Substitutions will be considered and approved if the requirements of the Contract Documents are satisfied. The Contractor shall be responsible for form and fit of all components and hardware, as necessary to meet the design intent and function required.
3. Malleable Iron: Fittings or components made of malleable iron shall be grade 32510 or better and shall conform to ASTM A47. All components and fittings shall be galvanized in accordance with ASTM A153.
4. Forged Steel: Material for forged steel shall comply with ASTM A711 or A668. All components and fittings shall be galvanized in accordance with ASTM A153.
5. Ductile Iron: Fittings, or components requiring high yield strength shall be of ductile iron, grade 60.40.18 or better and shall conform to ASTM A536. All fittings and components shall be galvanized in accordance with ASTM A153.
6. Stainless Steel: Stainless Steel hardware shall conform to ASTM A747.
7. Non-Ferrous Metals: Copper alloys for fittings and components shall conform with ASTM B30, B584 and B148.
8. Copper: All copper components shall conform to ASTM B248 or B249.
9. All cotter pins shall be made out of stainless steel.
10. The designated metals shall be produced by an approved method that will meet the requirements of the referenced Standards, these Specifications and the Contract Plans.
11. Castings shall be of uniform quality and shall be made in such a manner that the material of the casting conforms to the chemical and mechanical properties prescribed in the referenced ASTM Standards.
12. The castings shall be free of adhering sand, voids, cracks, surface porosity and non-uniform dimensions.
13. The Contractor shall be responsible for the dimensional accuracy of all fittings and hardware.
14. Repairs shall be permitted only to the extent allowed by the referenced ASTM Standards. If welding or repair of a greater magnitude is required, the Contractor shall obtain approval prior to processing.
15. All fittings and hardware used for catenary assemblies shall be selected and made such that they can be reused after removal.

16. All fittings and hardware shall be designed with maximum interchangeability and standardization for easy interface with the other components of the catenary system.
17. All fittings and hardware shall be designed and installed to provide a homogenous catenary hardware and assembly arrangement.
18. Components and assemblies shall be designed such that all fastenings and adjustments are accomplished with the same dimensional standards or tools.

E. Catenary Assemblies:

1. All materials used in the components or the support and registration assemblies shall be of sufficient strength and durability to withstand the loads as indicated on the Contract Plans, with the addition of a factor of safety of 2.5. Any substitution of materials shall be submitted to the Engineer for approval.
2. The material shall be light in weight and reliable to ensure a 30 year life period.
3. The assemblies shall be of a proven, tested and approved Metro North design, which shall have been used on previous Metro North overhead electrified railroad projects.
4. The Contractor shall furnish all labor, tools, equipment, apparatus and facilities as required to perform manufacture, supply, and installation work as required.
5. Malleable Iron: Fittings or components made of malleable iron shall be grade 32510 or better and shall conform to ASTM A47. All components and fittings shall be galvanized in accordance with ASTM A153.
6. Structural Steel: Material for structural steel shall comply with ASTM A36 or A588. A36 material must be galvanized in accordance with ASTM A123.
7. Stainless Steel: Stainless Steel material shall conform to ASTM A484.
8. Aluminum components shall conform to ASTM B150.
9. All cotter pins shall be made out of stainless steel.

F. Stainless Steel Wire Ropes and Rods:

1. The wire rope shall be shipped on reels suitable for the weight carried.
2. High corrosion resistant austenitic grade stainless steel compatible with component items shall be used.
3. The component items shall be designed to carry maximum working loads with a factor of safety of 2.5 minimum.

4. Stainless Steel Wire Rope shall be extra flexible and manufactured, and tested and in conformance with requirements of ASTM A368, A492, A555 and A580.
5. Stainless Steel Rod shall be round and manufactured and tested and in conformance with requirements of ASTM A276.

G. Uninsulated Wires:

1. Conductor materials shall be of a composition, quality and purity such that the finished product shall have the physical, mechanical, electrical properties, characteristics and parameters conforming to this Specification and the plans.
2. The conductors shall have a minimum in-service life expectancy of 30 years under normal operating conditions.
3. The conductors shall be unconditionally guaranteed by the manufacturer and/or supplier to be free from defects for a period not less than five (5) years.
4. The Engineer reserves the right to witness the manufacture, testing and packing of all conductors. The manufacturer shall notify the Engineer not less than 10 days in advance of manufacturing and testing operations.
5. All conductors shall be subject to factory quality control tests as required in the applicable Standards. Tests shall be performed on each reel prior to shipment. A certified copy of the test report for each reel shall be submitted to the Engineer prior to shipment. A copy of the test report shall be packed with each reel.
6. Grooved contact wire shall be subject to the twist test in addition to other required tests required by the applicable ASTM. The twist test shall be performed as specified for round wire, except that 6 twists shall be required. Contact wire not meeting this test will be rejected.
7. Each reel shall consist of one continuous, unspliced conductor; and shall have the required length of conductor so that no splices are required in the tension sections as installed unless approved by the Engineer.
8. Contact wire shall be permanently identified at intervals of 300 feet along its length on the surface of the top lobe, showing the manufacturer's marks, material, size in AWG and year of manufacture.
9. Each reel shall have a strong, weatherproof tag or marker securely fastened to it, showing the size and type of conductor as well as the ASTM designation, name and mark of the manufacturer, total reel length, and weight and manufacturer's special instructions.

10. A stripe in any contrasting color approximately 1" wide shall be painted across the outermost layer on each reel. Any visible conductor shift at this line, upon receipt at the job site, will be treated as indicating a relative wire movement during shipment, and is cause for reel rejection.
11. Joints in contact wire shall be marked with paint or dye prior to wire drawing. The marks shall be readily distinguishable after the wire drawing process.
12. Any damage to the wire shall be the Contractor's responsibility and all repairs and replacements of the damaged wires shall be at the Contractor's expense.

H. 750 KCMIL, 35 KV Shielded Copper Cable:

1. See Special Provision Item #0001139A for requirements of this cable.

Testing

A. Insulators:

1. Insulators shall be tested in accordance with NEMA C29.1
2. Factory tests shall be made as required by these specifications and the referenced standards. Test reports shall be submitted for approval of the Engineer.
3. The Engineer reserves the right to witness the manufacture, testing and packing of all insulators. The Contractor shall notify the Engineer not less than ten days in advance of manufacturing and testing operations.

Delivery, Storage and Handling

- A. The Contractor shall ensure that all materials furnished are suitably packaged, stored and protected from damage during handling, shipping, storage, exposure, and installation.
- B. Deliver the components to the site at intervals to ensure uninterrupted progress of the work and to not impede the progress of staged construction.
- C. All shipping boxes, bags, or crates shall be clearly and properly marked with strong waterproof tags securely fastened to the shipping vessel showing the contents of each. If different materials are packaged in a box, bag or crate, all items of kind shall be collectively boxed, bagged or crated in a properly marked or tagged prior to placement in the shipping vessel. The tags shall provide information including but not limited to the assembly or component name, number, or identification code.

- D. The materials, when necessary to store on site, shall be stored in a manner to permit easy access for inspection and identification in areas as designated on the plans or as directed by Engineer which do not impeded the progress of staged construction.
- E. The Contractor shall handle and otherwise use the components in accordance with the manufacturer's instructions, so as to ensure that the products are not damaged or misused prior to or during installation.
- F. Any damage to the components prior to acceptance by the Engineer shall be the Contractor's responsibility.
- G. Replacement of rejected components shall be accomplished by the Contractor in accordance with the manufacturer's instructions at no cost to Connecticut Department of Transportation.
- H. Protect steel members and packaged materials from corrosion and deterioration.
- I. Fittings and hardware shall be packaged in a manner to allow stacking and outdoor storage until installation with no harmful effects.
- J. Catenary Assemblies packing and/or packing methods of all assemblies or components shall be approved by the Engineer.
- K. Stainless Steel Rope and Rods shall be shipped on reels suitable for the weight carried or in straight lengths, securely bundled. Rods shipped on reels shall be straightened prior to use.
- L. Stainless Steel Rope and Rods shall be protected against damage during handling and shipping. Each reel or bundle shall have a strong, weatherproof tag securely fastened showing the physical and mechanical properties as well as type designation. ASTM designation and the name and mark of the manufacturer, the total length and weight of the wire rope, strand or rod on each reel or bundle
- M. Uninsulated Wire shall be shipped on wooden reels, suitable for the weight of the conductors and shall be protected from damage. The diameter of the drum shall be sufficiently large so as to avoid difficulty with waves or kinks when the conductor is strung. The grooved contact wire shall be wound on the reel in such manner that the vertical axis of cross section shall be parallel to the axis of the reel.

Execution

A. Construction Staging:

1. The Contractor is alerted to the constraints imposed on installation work due to the necessity for maintaining revenue electric train operations. Installation, adjustment and pre-revenue operation inspections of the longitudinal catenary wires shall be performed in discrete segments of the route as necessary to comply with these requirements.

2. Actual stringing, adjustment and pre-revenue testing of any specific system, or segment thereof, must be accomplished within the agreed line outage.
3. The Contractor may propose, for approval of the Engineer, alternate or extended construction limits or may propose advance construction of elements from later stages provided that the work will be accomplished during the agreed construction stages and work periods and the tracks will be placed in service in accordance with the overall work-plan.

Construction Methods:

A. Installation Tools:

1. The Contractor shall provide and maintain, subject to continual inspection by the Engineer, sufficient resources, including tools, mechanical equipment and apparatus necessary to complete the work in accordance with the Contract Drawings, this Specification and the agreed Systems Installation Plan. The equipment shall include all temporary materials, apparatus, consumable materials and any special tools recommended by the manufacturer for installing assemblies and arrangements. For dynamometers used, submit calibration certification certifying accuracy of the devices within the limits prescribed by the manufacturer. The Contractor shall be responsible to insure the continuing accuracy of these devices throughout the duration of their use.

B. All electrical connectors and clamps shall be prepared and protected externally and internally in accordance with the manufacturer's recommendations.

C. Pre-installed Assemblies:

1. Prior to stringing wires for the individual systems to be constructed during any stage, all permanent supporting poles, trusses, insulated supporting devices, insulated termination assemblies, wire anchors and guy assemblies shall be installed. The Contractor also shall install temporary guys where temporary dead-ending of wires will be necessary for construction staging and to avoid over stressing of structural elements during the stringing process. The Contractor shall review locations selected for such temporary guys with the Engineer.

D. Insulators:

1. All insulators shall be cleaned before and after installation. Only clean rags, free from any abrasive material shall be used for cleaning insulators. Wire brushes shall not be used for cleaning any parts, metal or otherwise. In the completed line, all insulator assemblies and hardware shall be clean, bright and free from nicks, chips or other marks.

E. Hardware:

1. All hardware shall be installed as indicated on the plans and as recommended by the manufacturer. Bolts and nuts shall be properly tightened in accordance with the manufacturer's recommendations. All bolts shall be of sufficient length for a full thread beyond the nut and/or locknut, but shall not protrude beyond the nut and/or locknut more

than ½ of an inch. Bolt ends shall not be cut off. Where locknuts are not used, lock washers shall be provided.

2. Hardware shall be installed using tools and methods specified by the manufacturer and approved by the Engineer.
3. Hardware shall be inspected for cleanliness and damage. Any item that does not fit, creates scraping of galvanizing during installation, or is found defective shall be rejected. Replacement, prior to acceptance by the Engineer, shall be at the Contractor's expense.
4. Cotter pins shall be installed with the open end toward the ground.

F. Connectors:

1. Current-carrying connectors, shall be as shown on the plans and shall be installed in accordance with the manufacturers recommendations. Connectors for copper or bronze wire shall be copper or bronze. Connectors for bi-metallic connections shall be tin plated.
2. Bolts in bolt-type connectors shall be lubricated as recommended by the manufacturer and torqued to the manufacturer's recommendation, using a calibrated torque wrench.
3. Connectors shall preferably be factory-loaded with a corrosion inhibitor which is made for the specific purpose.
4. Wire surfaces which are in contact with conducting surfaces of the connector shall be thoroughly wire brushed and an inhibitor applied. Where connectors are not factory-loaded with a corrosion inhibitor, the same inhibitor shall be applied in the field to the connector.
5. Corrosion inhibitors shall be stable over a wide temperature range, adhere to cold metal surfaces, be water-repellent, weather resistant and inert to copper, aluminum, zinc, tin, cadmium, steel and neoprene rubber. Grit-bearing inhibitors shall be used except for flat lugs, sliding surfaces or where not recommended by the connector manufacturer. Grit shall be compatible with the connector and wire metal. Inhibitor for copper and bronze shall be T&B "Kopr Shiel", Fargo "Farpolene", Penn-Union "Cual-Aid", Burndy "Penetrox A", or approved equal.
6. One typical full-tension test of each type of splice for each type of conductor shall be fabricated and tested by an independent testing laboratory approved by the Engineer or by another means acceptable to the Engineer.
7. Supporting Devices and assemblies used for holding wires in the correct horizontal and vertical position, shall be fabricated and installed in accordance with the manufacturer's instructions. It is suggested that the Contractor take field measurements at the support location, immediately prior to the fabrication of such support assemblies, to determine the as-built conditions.

G. Conductors:

1. For each length of conductor installed, a record shall be kept by the Contractor of the reel number from which the conductor was used. Partly used reels shall be recorded as such.
2. All conductors shall be handled in accordance with good overhead line practice and the manufacturer's recommendations.
3. Conductors shall normally be ordered with one continuous length on one reel to satisfy several runs. As the length required to install each run is removed, the length remaining on the reel shall be determined and recorded both on the reel and on substantiating documentation.
4. Care must be taken with handling reels so as not to prejudice the stringing operation. Damaged reels shall be set aside for repair before use.
5. For tension conditions wire temperatures shall be measured by thermometer. The bulb of the thermometer shall be in intimate contact with the wire and shall be closely taped to the wire to prevent drafts around the bulb. The thermometer shall be read after 15 minutes of contact.
6. A record of wire temperature and the tension recorded at both ends of the tension sections shall be kept for all conductors. A copy shall be given to the Engineer within 7 days of measurement.

H. Installation of Conductors:

1. Wires shall not be strung without the guy anchor assemblies being in place, ready to receive loads. Where necessary for staging of the work, the Contractor shall install temporary guy assemblies at locations agreed in conjunction with the Engineer. The Contractor shall provide any temporary anchors and down guys required to facilitate installation and construction staging at his own expense.
2. The Contractor's sequence and methods of erecting the individual wires shall be furnished for approval of the Engineer.
3. Care shall be taken to prevent kinks or other damage in the wires and cables. The Engineer reserves the right to reject any wire in its entirety if it is judged that any damage will prejudice performance and/or service life. "Bird-caging" of stranded wire shall be cause for rejection.
4. The erection tension in any conductor shall be as shown on the plans with tolerance of plus/minus 5 percent.
5. In general, one splice will be permitted in an entire length of conductor run. Additional splices in any specific wire run shall be subject to the approval of the Engineer.

6. Splices will not be permitted within 5 feet of a support clamp.
 7. Any damage to the conductors shall be immediately reported verbally to the Engineer. Remedial action must be approved by the Engineer and will be performed as directed by the Engineer at the Contractor's expense. Within 5 days of the verbal report and action determined, the Contractor shall submit a Conductor Damage Report describing the damage and remedial action, in writing, to the Engineer.
 8. Roller-bearing sheaves of the closed type shall be used at all support points for stringing. Sheaves shall be of sufficient size to accommodate the conductor without damage.
 9. Dynamometers, or other tension measuring devices, shall be calibrated not more than one month prior to use on this Contract and shall be calibrated at monthly intervals, or as approved, during the Contract.
 10. Stringing of the wires shall start from an anchor location. At splice locations, the existing conductor shall be rigged to relieve tension, the wire cut and the splice between existing and new wire installed. After the initial termination is made, the conductor shall be pulled from the reel and lifted into the sheaves at each support. Sufficient tension must be maintained in the conductor during stringing to ensure that, under no circumstances, does the conductor touch the ground or the track between support points.
 11. When the second anchor location is reached, a tensioning rig shall be erected on the pole, anchoring point or on the existing conductor, as appropriate. The rig shall contain a dynamometer or other device for measuring tension. If the first termination point was a splice location, the tensioning rig at the cut conductor point shall be gradually eased as tension is applied at the second termination point. The changeover in tension from the existing conductor to the new conductor shall be coordinated carefully, preferably by radio, in order to avoid damage to the conductors at the initial splice location. After satisfactory transfer of tension, the wire shall be tensioned above the specified erection tension to minimize future creep. The required over-tensioning amount shall be established by the Contractor in conjunction with the wire manufacturer, bearing in mind the time constraints on construction. This tension shall then be slackened to the specified erection tension, and the dead-end assembly attached.
 12. Erection tensions shall be governed by the plans, based on the equivalent span for the tension length and temperature of the conductor. The Contractor shall submit his stringing procedure to the Engineer for approval.
 13. During stringing of new conductors, proper vertical and horizontal electrical clearances must be maintained away from existing conductors and structures.
- I. Catenary System:
1. Contact wires shall be erected in temporary wire loops attached to the messenger wire at appropriate intervals and lengths. "Figure Eight" loops made of No. 9 iron wire annealed,

or other approved loops, may be used. In any case, the contact wire shall not be restrained from longitudinal movement during tensioning.

2. Contact wires shall be held in proper lateral position at the support, in relation to the center line of elevated track, using temporary rollers to prevent kinking.
3. Similar preparations, as described for other wires, shall be employed at commencement of stringing, and for tensioning of the contact wire.
4. Final adjustment of catenary messenger, aerial ground wire and traction power feeder to the specified stringing tension shall be made progressively, working any slack from the first anchor location toward the second anchor location at the other end of the run.
 - a. Final adjustment to the specified stringing tension shall be made progressively, working any slack from the first termination location toward the second anchor or splice location at the other end of the run.
 - b. The tension in the wire shall be adjusted so that it is within 5%, plus or minus, of the erection tension derived from the charts.
 - c. When the proper tension has been obtained, the conductor shall be secured clamped in permanent position.
 - d. Contact wires shall be tensioned in accordance with the tensions shown on the plans for the appropriate equivalent span and temperature. The contact wire should be over tensioned by an amount necessary to minimize future elongation. The required over-tensioning amount shall be established by the Contractor in conjunction with the wire manufacturer, bearing in mind the time constraints on construction.
 - e. Turnbuckles and other adjustable fasteners shall have at least 60-percent of their take-up adjustment remaining to provide for future maintenance.

J. Hangers:

1. Hanger lengths for each installed span shall be determined by the Contractor based on the data given on the plans.
2. Hangers shall be fabricated to a tolerance of plus/minus 1/4 inch.
3. The along-track position of each hanger shall be within plus/minus 2 inches of the design position.
4. As the hanger clips are fastened and steady arms attached, any twist in the contact wire shall be removed by working from one anchor to the other.
5. As far as practicable, bolts shall be installed in the various clips so that the nuts will be on the same side giving a uniform appearance. On curves, the nuts shall be placed on the inside of the curve to provide the best clearance to the pantograph.

6. Saddles for loop-type hangers shall clamp the messenger tightly. The loops shall have a loose fit around the saddle, permitting free rise and fall without binding.
- K. Wire pull-offs shall be installed as necessary and in locations as shown on the plans. The Contractor shall furnish and install such additional wire pull-offs as necessary to support and locate wires in the optimum position for operations during the staging work.
- L. Crossed-contact wire assemblies shall be fitted at all in-running contact wire crossings as necessary and as shown on the plans.
- M. Catenary jumpers shall be installed as indicated on the Contract Drawings and as directed by the Engineer.
- N. Jumpers shall protrude through their clamps ½" maximum, and jumper ends shall be wrapped.
- O. The configuration of jumpers shall make due allowance for the relative movement between conductors for all temperatures.
- P. Final Adjustment:
 1. Catenary System
 - a. After catenary tensioning has been completed, hangers and clips fastened, steady arms erected, and pull-offs installed, a check of the construction and adjustment to final position shall be made.
 - b. Any hangers with improper fit shall be replaced with hangers of proper length.
 - c. Height and lateral position of the contact wire shall be checked in accordance with the plans and adjusted where necessary and is to be measured normal to the track along the elevated centerline. To accommodate construction staging, the Contractor may, subject to approval of the Engineer, leave final adjustment of partly constructed catenary systems to a later stage provided that the installation will not impact railroad operations.
 - d. The contact wire height given in the plans is the height at mean ambient temperature (60°F).
 - e. Where the normal height of contact wire is 18'-0" and above, a tolerance of plus 3" from the height shown on the plans will be permitted, except at the interface with existing system. The contact wire gradient between any two adjacent structures shall not exceed 1 in 100 relative to track, subject to maintaining safe pantograph operation.

- f. Midspan heights must be at the average of the support heights at the structures at each end of the span.
- g. The staggers of the contact wire shown on the plans are relative to the inclined centerline of track which coincides with the nominal centerline of the static pantograph.
- h. The lateral position of the contact wire will vary with the curvature and span length. The stagger at each support shall be as shown on the plans.
- i. The installation tolerance for contact wire stagger shall be plus/minus 1 inch on the values specified on the plans. When required to achieve acceptable midspan offset, this tolerance may be increased with the approval of the Engineer.
- j. The messenger wire generally shall be installed vertically above the final staggered contact wire. An allowance of plus or minus 2 inches will be permitted on system heights 2 feet and above.

Q. Field Measurement and Clearance Check of Catenary System.

- 1. The following measurements shall be made and recorded with the catenary in its final position:
 - a. Messenger and contact wire heights above each track at each catenary support point and at midspan.
 - b. Wire temperature and air temperature including time of day.
 - c. Contact wire stagger relative to design superelevated track centerline at each registration point and at midspan.
 - d. Track centerline to face of pole at rail level at each structure location, actual track superelevation and pole deflection at contact wire level.
 - e. A complete set of the final wire heights and stagger dimensions, as accepted, shall be made available to the Engineer at the final inspection.
 - f. The Contractor shall make a physical/mechanical clearance check, using a pantograph height and stagger gauge fitted with removable clearance ears. If fouling occurs at any point, it shall be brought immediately to the attention of the Engineer.
 - g. The physical/mechanical clearance shall allow for 3" of uplift of the contact wire with an additional allowance of 3" for mechanical clearance, except at the steady arm where 1" minimum mechanical clearance shall be allowed.

R. Pantograph Running Tests:

1. After installation of the individual catenary systems and prior to acceptance of the line for normal electric operations, Metro North reserves the right to conduct pantograph tests on the catenary, using a vehicle with the pantograph in contact with the contact wire. These tests are to assure a smooth, shock-free passage of the pantograph with no interruption to current collection especially at turnouts, section insulators, and overlaps. Particular attention will be focused on wire takeover at overlaps, turnouts and crossovers, and the lack of arcing at all locations. The Contractor shall be responsible for all adjustments required as a result of these tests.

S. Grounding and Bonding Systems:

1. General

- a. The work shall be arranged in such a manner that each part of the grounding system which is laid below finished grade shall be completed, tested and inspected by the Engineer before backfilling is done. All precautions shall be taken to assure that no damage is done to the grounding and bonding conductors or connections during backfilling, compacting and concreting operations. Testing for ground resistance shall be performed in accordance with the requirements of this Specification before any finish surfacing is laid above the grounding and bonding conductors.
- b. Ground tap connections between disconnect switch supporting steelwork and ground cables shall be provided, as shown on the plans. All paint, scale, rust, oxidation, or other foreign material shall be thoroughly removed from the points of contact on all metal surfaces before any ground connections are made.

2. Buried Ground Conductors:

- a. The size and type of the buried ground conductor shall be as indicated on the plans.
- b. Conductor connections shall be made as shown on the plans and as necessary to suit the application. Finish welds shall be cleaned and coated with an approved cold applied bituminous resin compound. Primer shall be as recommended by the coating manufacturer.
- c. Aerial ground wires shall be interconnected to the new and existing aerial grounding system as shown on the plans.

T. Grounding and Bonding Systems Field Testing:

1. General

- a. Testing shall be performed by the Contractor.
- b. Ground resistance tests shall be made with a James G. Biddle Company Model 250220, Heavy-Duty, Megger Insulation Tester, or approved equal using the three-probe method described in IEEE Standard 81.

2. Field testing shall be thorough and fully documented, with the following as a minimum:

- a. Electrical resistance tests shall be made during installation, to verify continuity of the grounding systems, before and after connection to the existing railroad grounding system.
- b. Measure, record and report the resistance to earth of each portion of the grounding system as soon as possible after installation so that corrective measures, if required, may be made with minimum disruption of construction. The required ground resistance is 5 ohms or less. Corrective measures shall be taken by the Contractor to achieve the specified ground resistance.
- c. Resistance-to-earth tests shall be coordinated with and witnessed by the Engineer, and the written results of these tests shall be submitted to the Engineer for evaluation and instructions regarding any corrective action which may be deemed necessary.

U. Catenary Assemblies:

1. All supporting devices including steady arms, messenger supports, cross span and steady wire or wire pull-off registration assemblies shall be installed as indicated on the Contract Plans and as instructed by the manufacturer.
2. All connections, bolts, and nuts shall be properly tightened in accordance with the manufacturer's recommendations.
3. All items shall be inspected for fit, damaged coating or bent/kinked members. Any piece found to be defective shall be rejected and a replacement shall be installed at the Contractor's expense.
4. Cantilevers and other assemblies shall be installed as indicated on the Contract Plans and in accordance with the manufacturer's instructions. The Contractor shall take field measurements immediately prior to cantilever fabrication, to determine the as-built cantilever reach from the elevated track centerline to face-of-pole at either contact wire height or messenger wire height. Due allowance shall be made, during cantilever fabrication, for any dead load deflection of the pole.
5. The wire heights and stagger given on the Contract Plans are related to the track high rail level and the projected track centerline.
6. For stability during stringing, cantilevers and other pivoted assemblies shall be temporarily restrained to prevent collapse due to swinging, to be provided at the Contractor's expense. The details of the restraint shall be submitted to the Engineer for approval.
7. Cotter Pins and nuts on each cantilever shall be located on the same side of the structure to assure uniformity along the line.

8. Assemblies fitted with pins, cutters, bolts and nuts shall be oriented where possible in such a manner as to lock these components together by gravity if the pins or nuts should become detached under service conditions.
9. Components employing a hinge or swivel shall be greased with an approved grease before assembly of the rubbing surfaces.
10. After installation of cantilevers and independent support and registration assemblies and stringing of conductors, adjustment may be required to the stagger, heel setting, contact wire height and insulator or cantilever inclination, to be within the specified design tolerances.
11. Conductor interfaces of all clamps for feeder jumpers, full feeding jumpers, tap wires, equalizing jumpers and in-span jumpers shall be coated with conductive grease.
12. Prior to installation of cross span and steady wire assemblies, the Contractor shall record the following field details along the axis of the spans for review by the Engineer:
 - a. Pole to pole, track to track, and track to pole centerline dimensions.
 - b. Relative cross-track elevations of tops of foundations and tracks.
 - c. Track superelevations and directions facing towards higher station numbers.
13. The Contractor shall review and note all field changes from the design, and submit these changes together with his recommendations to the Engineer for approval.
14. Wire sizes, location of turnbuckles, insulators, suspension assemblies, and hangers for the OCS shall be installed in accordance with the Contract Plans or as directed by the Engineer.
15. Field adjustments of hangers, contact and messenger wire heights shall be performed by the Contractor.
16. Stagger, wire heights, and heel setting of the steady arm shall be in accordance with the Contract Plans or as directed by the Engineer.
17. Attachment heights and loadings for cross spans and steady wire shall be fully developed in the Contractors calculations for each location in accordance with standards indicated on the Contract Plans.

Method of Measurement:

A. Catenary Systems:

1. The quantity of catenary system to be measured for payment will be the length of each individual catenary system, including fabrication, supply, installation and adjustments of all new wires and conductors, hangers, insulated and non-insulated support and registration assemblies, termination/anchor assemblies, in-span assemblies, pull-off assemblies, jumpers and their connections, sectionalizing assemblies, crossing wire arrangements and all associated connectors, splices, in-span components, hardware and fittings and miscellaneous steel assemblies necessary to form the complete functioning catenary system.
2. Measurement will be made from anchor to anchor as shown on the plans. No adjustment for additional lengths required for construction purposes. No separate extra measurements will be made for the interface with existing catenary.
3. The measurement of each catenary system shall also include the modifications and adjustments to existing interconnected or otherwise interfacing catenary systems, and all else necessary to provide smooth pantograph operations between new catenaries and existing catenaries.
4. No separate measurement will be made of temporary material required to accomplish the work through the various construction stages, the cost of which shall be included in the price bid for the item "Catenary Systems", including but not limited to, temporary wires and conductors, insulated and non-insulated support assemblies, termination/anchor assemblies, in-span assemblies, sectionalizing assemblies, connectors, splices, hardware and fittings, temporary guying, damaged materials, or complete systems rejected for any reasons.
5. It may be necessary to add or to substitute assemblies called for on an erection diagram bill of material in order to meet the requirement that the Contractor provides a complete functioning catenary system. No separate payment will be made for such changes but the cost thereof shall be included in the price bid for the item "Catenary Systems".

B. Aerial Ground Wire Systems:

1. The quantity of Aerial Ground Wire Systems to be measured for payment will be the length of each individual Aerial Ground Wire System, including fabrication, supply, installation and adjustments of all new wires and conductors, insulated and non-insulated support assemblies, termination/anchor assemblies, in-span assemblies, sectionalizing assemblies and all associated connectors, splices, in-span components, hardware and fittings and miscellaneous steel assemblies necessary to form the complete functioning Aerial Ground Wire System.
2. Measurement will be made from anchor to anchor as shown on plan.

3. No separate measurement will be made of temporary material required to accomplish the work through the various construction stages, the cost of which shall be included in the price bid for the item "Aerial Ground Wire Systems", including but not limited to, temporary wires and conductors, support assemblies, termination/anchor assemblies, in-span assemblies, connectors, splices, hardware and fittings, temporary guying, damaged materials, or complete systems rejected for any reasons, the cost of which shall be included in the price for the applicable bid item.
4. Ground rods and their connections to the aerial ground wires and other work associated with grounding of catenary structures (except grounding for switches) will not be paid for separately but their cost shall be covered as a part of the price for item "Aerial Ground Wire Systems".
5. It may be necessary to add or to substitute assemblies called for on an erection diagram bill of material in order to meet the requirement that the Contractor provides a complete functioning aerial ground wire system. No separate payment will be made for such changes but the cost thereof shall be included in the price bid for the item "Aerial Ground Wire Systems".

C. Traction Power Distribution Systems

1. The quantity of Traction Power Distribution Systems to be measured for payment will be the length of each individual Traction Power Distribution System, including fabrication, supply, installation and adjustments of all new wires and conductors, insulated and non-insulated support assemblies, termination/anchor assemblies, in-span assemblies, sectionalization assemblies, wood pole deadend assembly, feeder termination assembly, pin insulator assembly, jumper cable assembly, lightning arrestor assembly, switching assembly, cable in crossing conduit, pole reinforcement, and all associated connectors, splices, in-span components, hardware and fittings and miscellaneous steel assemblies to form the complete functioning Traction Power Distribution Systems.
2. The quantity of Traction Power Distribution Systems Feeder Systems will be measured for payment by the actual linear foot installed between:
 - a. YD 4 Feeder: Breaker panel in Substation 1086 to new switch on WEY 26.
 - b. F2 Snowmelter Feeder: WEY 43 to WEY 21.
3. Line feeder disconnect switches and interconnecting jumpers between the feeder line and catenary including their associated connections, shall be paid for separately.
4. No separate measurement will be made of temporary material required to accomplish the work through the various construction stages, the cost of which shall be included in the price bid for the item "Traction Power Distribution Systems", including but not limited to, temporary wires and conductors, insulated and non-insulated support assemblies,

termination assemblies, in-span assemblies, sectionalization assemblies, connectors, splices, hardware and fittings, temporary guying, damaged materials, or complete systems rejected for any reasons.

- 5. It may be necessary to add or to substitute assemblies called for on an erection diagram bill of material in order to meet the requirement that the Contractor provides a complete functioning traction power distribution system. No separate payment will be made for such changes but the cost thereof shall be included in the bid price for the item "Traction Power Distribution Systems".

Basis of Payment:

- A. The quantity of Catenary System supplied and installed, in accordance with these specifications, shall be paid for at the contract unit price per linear foot.
- B. The quantity of Aerial Grounding System supplied and installed, in accordance with these specifications, shall be paid for at the contract unit price per linear foot.
- C. The quantity of Traction Power Distribution System supplied and installed, in accordance with these specifications, shall be paid for at the contract unit price per linear foot.

<u>Pay Item</u>	<u>Pay Unit</u>
Catenary Systems	LF
Aerial Ground Wire Systems	LF
Traction Power Distribution Systems	LF

ITEM #0100411A - 150 KVA PAD MOUNTED DISTRIBUTION TRANSFORMER

ITEM #0100416A - 750 KVA PAD MOUNTED DISTRIBUTION TRANSFORMER

Description:

Scope

The work under these items shall consist of furnishing and installing pad mounted distribution transformers sized as indicated at locations shown on the plans. Transformers shall be outdoor type, liquid-immersed, continuous duty, integral assembly, grounded, tamper-resistant and weatherproof.

Related Work

Related requirements are included in, but not limited to, the following:

1. PVC Duct Bank Items
2. RGS Conduit in Trench Items
3. 600 Volt Copper Wire items
4. 500 KCMIL, 15 KV Shielded Copper Cable

Submittals

Submit the following:

- A. Shop Drawings:
 1. Sufficient information, clearly presented, shall be included to determine compliance with plans and specifications.
 2. Include electrical ratings, impedance, dimensions, weight, mounting details, decibel rating, termination information, temperature rise, no load and full load losses, regulation, over current protection, connection diagrams, and accessories.
 3. Complete nameplate data including Manufacturer's name and catalog number.
- B. Manuals:
 1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
 - a. Identify terminals on wiring diagrams to facilitate installation, maintenance and operation.
 - b. Indicate, on wiring diagrams, the internal wiring for each item of equipment and interconnections between the items of equipment.
 - c. Approvals will be based on complete submissions of manuals together with shop drawings.

2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operation manuals to the Engineer.
 - a. Update the manual to include any information necessitated by shop drawing approval.
 - b. Show all terminal identification.
 - c. Include information for testing, repair, trouble shooting, assembly, disassembly, and recommended maintenance intervals.
 - d. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
 - e. Furnish manuals in loose-leaf binder or manufacturer's standard binder.
- C. Certifications:
1. Two weeks prior to the final inspection, submit four copies of the following certifications to the Engineer:
 - a. Certification by the Manufacturer that the equipment conforms to the requirements of the plans and specifications.
 - b. Certification by the contractor that the pad mounted transformers have been properly installed, connected and tested by an independent agency.

Spare Parts

- A. Deliver the following spare parts and any other recommended spare parts for the project to the Engineer two weeks prior to final inspection:
 1. Six stand-off insulators.
 2. Six insulated protective caps.
 3. One spare set of high voltage fuses for each size fuse used in the project.

Instructions

The contractor shall instruct Metro-North RR maintenance personnel, for not less than one (1) 2-hour period, on the maintenance and operation of the equipment on the date requested by the Engineer.

Materials:

Equipment, General

- A. Equipment shall be in accordance with ANSI, ASTM, IEEE, NEMA, NFPA, UL, as shown on the Plans and as hereinafter specified.
- B. Ratings shall not be less than shown on the plans.
- C. Provide units designed to withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses that may occur during operation.

- D. Completely fabricate units at the factory so that only the external cable connections are required at the job site.
- E. Thoroughly clean, phosphatize and finish all the metal surfaces at the factory with a rust-resistant primer and dark green enamel finish coat.
- F. All surfaces of the unit that will be in contact with the concrete pad shall be treated with corrosion-resistant compounds and epoxy resin, or a rubberized sealing compound.

Compartments

A. Construction:

- 1. The high and low voltage compartments and the transformer compartment shall be fabricated by a single manufacturer. The compartments and the transformer tank shall be assembled as an integral unit by a single manufacturer. Enclosures shall be in accordance with ANSI C57.12.29 (being installed in coastal environment).
- 2. The high and low voltage compartments shall be separated with a steel barrier.
- 3. The compartments shall be constructed of sheet steel (gage to meet ANSI requirements) with bracing, reinforcing gussets and jig-welding to assure rectangular rigidity.
- 4. Use cadmium or zinc plated bolts, nuts and washers.
- 5. Sufficient space shall be provided for equipment, cabling and terminations in the compartments.
- 6. Affix the transformer instruction nameplate permanently to the unit within the low voltage compartment. Voltage ratings, kVA rating, connection configuration, impedance, date of manufacture and serial number shall be shown on the nameplate.
- 7. The compartment depth shall be in accordance with IEEE Std C57.12.34-2009 standard, unless additional depth is specified.
- 8. The exterior of the unit shall be painted standard enamel ANSI 61 gray in color. The cabinet interior and front plate shall be painted gray for ease of viewing the inside compartment.

B. Doors:

- 1. Provide a separate door for each compartment with provision for a single padlock to secure the compartment area. The high voltage compartment door shall be prevented mechanically from opening, unless the low voltage door is opened.
- 2. The secondary compartment door shall have a one-piece steel handle and incorporate three-point locking mechanisms to assure a secure and tight door closing. Provide each compartment door with open-position doorstops and tamperproof hinges. The hinge assembly shall be made of corrosion-resistant material welded in place.

Bil Rating

- A. 15 kV class equipment shall have a minimum 95 kV BIL rating.

Transformer Fuse and Fuse Assembly

- A. The transformer primary fuse assembly shall be load break combination fuse and dry-well fuse holder rated for system voltage, for 10 load makes and 10 load breaks with rated 200 amp load current at 75 percent power factor, 10,000 symmetrical amperes close-in on fault duty, and 95 kV BIL. The entire fuse assembly shall be removable through the use of a hot stick.
 - 1. The fuses shall be concealed, hot stick removable, 50,000 ampere symmetrical interrupting, 15 kV class, non-expulsion, current-limiting primary distribution type, size as shown on the Plans. The fuses shall operate within the fuse holder as a unit disconnecting means. Fuses shall be in accordance with ANSI C37.47.
 - 2. Transformers shall not have internal "weak link" fuses requiring transformer tank cover removal for replacement.

Primary Connections

- A. Transformer primary connections shall be 200A radial, feed, dead front load break wells and inserts for cable sizes shown on the Plans.

High Voltage Switching

- A. The transformer primary disconnect switch for radial feeds shall be an oil-immersed, internal, gang-operated, load-interrupter type, rated 200 amperes, with a close-in on fault duty of 5,000 amperes symmetrical at 15 kV. The switch is to be a two-position, on-off, manual switch located in the high voltage compartment and hot stick operated as described in the following.
 - 1. Continuous current 200 amperes. A built in switch with momentary current 10,000 amps symmetrical (2 seconds). Make and latch 6,000 amps symmetrical. Load interrupting 200 amps.

High Voltage Preformed Terminations

- A. Terminate the high voltage cables in the high voltage compartment with load break premolded rubber elbow connectors. Elbow connectors shall have a minimum of 0.125 inch semi-conductive shield material covering the housing. Each connector shall be tested - prior to shipment from the factory.
- B. Ground metallic cable shields with a device designed for the purpose. It shall consist of a solderless connector enclosed in watertight rubber housing covering the entire assembly. The grounding device and elbow connector are to be of the same manufacturer to insure electrical integrity of shielded parts.
- C. Premolded parts shall be suitable for submersible applications.
- D. Elbow connectors shall be rated as follows:
 - 1. Voltage: 14.4 kV phase-to-phase.
 - 2. BIL: 95 kV.
 - 3. AC withstands: 34 kV, 60 Hz for 1 minute.
 - 4. DC withstands: 65 kV (field test rating).

5. Corona voltage: 11 kV minimum.
6. Continuous current: 200 amperes RMS.
7. Short time current: 10,000 amperes for 12 cycles.
8. Fault closure: 10,000 amperes RMS symmetrical for 10 cycles (after 10 loadmake/loadbreak operations at 200 amperes and 14.4 kV contact voltage).
9. Switching: 10 loadmake/loadbreak operations at 200 amperes, 70-80 percent power factor, and 14.4 kV maximum recovery voltage between contacts.
- E. Interchangeability: The separable connector system shall include the loadbreak elbow, the bushing insert, and bushing well. Separable connectors shall comply with the requirements of IEEE 386, and shall be interchangeable between suppliers. Loadbreak elbow and bushing insert shall be from the same manufacturer.
- F. Allow sufficient slack in high voltage cable, ground, and drain wires to permit elbow connectors to be moved to their respective parking stands.
- G. Provide insulated cable supports to relieve any strain imposed by cable weight or movement.

Low Voltage Equipment

- A. The low voltage leads shall be brought out of the tank by epoxy, pressure tight bushings, and shall be standard arrangement per ANSI.
- B. Tin plate the low voltage neutral terminal and isolate from the transformer tank. Provide a removable ground strap sized in accordance with the NEC and connect between the neutral and ground pad.

Transformers

- A. Transformers shall be three-phase, liquid-immersed, isolated winding, and self-cooled by natural convection. Primary conductor material shall be copper.
- B. The kVA ratings shown on the Plans are for continuous duty without the use of cooling fans.
- C. Temperature rises shall not exceed the NEMA TR1 standards of 65 degrees C by resistance, and 80 degrees C hot spot at rated kVA.
- D. Transformer insulating material shall be mineral oil and shall be in accordance with ASTM D 3487.
- E. Transformer impedance shall be not less than 4.5 percent for sizes 150 kVA and larger. Nominal value for transformer impedance shall be 5.75%.
- F. Sound levels shall conform to NEMA TR1 standards.
- G. Primary and Secondary Windings for Three-phase Transformers:
 1. Primary windings shall be delta connected.
 2. Secondary windings shall be wye connected, except where otherwise indicated on the Plans. Provide isolated neutral bushings for secondary wye connected transformers.
 3. Secondary leads shall be brought out through pressure-tight epoxy bushings.
- H. Primary windings shall have four 2-1/2 percent full capacity voltage taps; two taps above and two taps below rated voltage.
- I. Core and Coil Assemblies:

1. Cores shall be grain-oriented, non-aging, and silicon steel to minimize losses.
 2. Core and coil assemblies shall be rigidly braced to withstand the stresses caused by rough handling during shipment, and stresses caused by any possible short circuit currents.
 3. Coils shall be continuous winding type without splices except for taps.
 4. Coil and core losses shall be optimum for the most efficient operation.
 5. Primary, secondary and tap connections shall be brazed or pressure type.
 6. Provide end fillers or tie downs for coil windings.
- J. The transformer tank, cover, and radiator gage thickness shall not be less than that outlined in ANSI.
- K. Accessories:
1. Provide standard NEMA features, accessories, and the following:
 - a. No-load tap changer (Provide warning sign).
 - b. Lifting, pulling and jacking facilities.
 - c. Globe-type valve for oil filtering and draining, including sampling device.
 - d. Pressure relief valve.
 - e. Liquid level gage and filling plug.
 - f. A grounding pad in the high and low voltage compartments.
 - g. A diagrammatic nameplate and operating instructions enclosed by a transparent cover located in the low voltage compartment.
 - h. Dial type liquid thermometer with a maximum reading pointer and an external reset.
 - i. Hot stick. Securely fasten hot stick within low voltage compartment.
 2. The accessories shall be made accessible within the compartments without disassembling trims and covers.

- L. Liquid filled transformers shall meet the minimum energy efficiency values per NEMA TP1:

KVA	(%)
75	98.1
112.5	98.3
150	99.0
225	99.0
300	99.0
500	99.1
750	99.2
1000	99.2
1500	99.3
2000	99.4
2500	99.4

Concrete Slab Foundation

- A. Concrete shall conform to the requirements of Article M.03.01 for Class "F" Concrete.
- B. Air-entraining Portland cement and air-entraining admixtures shall conform to Article M.03.01.
- C. Gravel base shall be compacted granular fill and conform to the requirements of Article 2.14.02.
- D. Reinforcement shall conform to requirements of Article M.06.01.
- E. Size and dimensions indicated on the plans are considered minimum dimensions. If Manufacturer calls for larger slab foundation dimensions, Contractor shall notify the Engineer and submit plan for Designer review.

Construction Methods:

Installation

- A. Install transformers as shown on the Plans, in accordance with the NEC and as recommended by the equipment manufacturer.
- B. Foundation:
 - 1. Excavation shall be made to the required depths below the finished grade, as shown on the Plans or as directed. All soft and yielding material shall be removed and replaced with suitable material.
 - 2. Gravel base or sub-base shall be as indicated on the plans. The base shall be wetted and rolled or tamped after the spreading of each layer.
 - 3. Provide foundation of reinforced concrete as indicated on the plans.
 - 4. Locate the top of foundation pads 2-inches above the adjacent finished grade, unless otherwise shown on the plans. Refer to plans for size, location, and steel reinforcing required.
 - 5. Grade the adjacent terrain so that surface water will flow away from the foundation.
 - 6. Anchor the transformers with cadmium or zinc plated bolts, nuts and washers. Bolts shall not be less than 1/2-inch diameter and placed as recommended by the Manufacturer.
 - 7. The installation of the service conduit of the size and type specified, and all conduits required in the concrete pad, shall conform to the provisions of Article 10.08.03 for the type of installation required.
 - 8. Conduit, inserts, sleeves and fittings shall be placed in proper positions and shall be so held until the concrete sets. Forms shall not be removed until the concrete has hardened properly and not less than 24 hours after the concrete has been placed.
 - 9. Forms: Forms shall be of metal or wood, straight, free from warp and of sufficient strength to resist springing from the pressure of the concrete. If made of wood, they shall be of 2-inch surfaced plank except that at sharp curves thinner material may be used. If made of metal, they shall be of approved section and shall have a flat surface on the top. Forms shall be of a depth equal to the depth of the pad. Forms shall be securely staked, braced and held firmly to the required line and grade and shall be sufficiently tight to prevent leakage of mortar. All forms shall be cleaned and oiled or wetted before concrete is placed against them.
 - 10. Concrete: The concrete shall be proportioned, mixed, placed, etc., in accordance with the provisions of Section 6.01 for Class "F" Concrete, except as modified herein. The concrete shall contain not less than 5% nor more than 7% entrained air at the time the concrete is deposited in the forms. Air-entrainment shall be obtained and the concrete cured in accordance with the provisions of Article 4.01.03 for Concrete Pavement.
 - 11. Finishing: The surface of the concrete shall be finished per Article 4.01.03.5.c, 4.01.03.5.d, 4.01.03.5.e, and 4.01.03.5.f. In addition to the requirements of 4.01.03.5.f, the pad shall have a 1% minimum slope to drain, and outside edges of the slab and all joints shall be edged with a 1/4-inch radius edging tool. Each slab

shall be divided into sections as shown on the plans by forming dummy joints with a jointing tool as directed.

12. Backfilling and Removal of Surplus Material: The sides of the pad shall be backfilled with material as shown on the plans. All surplus material shall be removed and the site left in a neat and presentable condition to the satisfaction of the Engineer.

C. Grounding:

1. Ground each pad mounted transformer in accordance with the requirements of the NEC. Unless otherwise indicated on the plans, install 3/4-inch diameter by 10 feet long copper-clad ground rods, driven 10 feet below grade to maintain a maximum resistance of five ohms to ground. Thermite weld the cable to the ground rods.
2. Connect the ground rod to the ground pads in the high and low voltage compartments, and to the secondary (and primary) neutral with not less than a 2/0 AWG bare copper conductor.
3. Independently connect cable shield grounding devices ground wires to ground with sufficient slack to permit elbow connector operation. Connect elbow connectors with a No. 14 AWG bare copper drain wire from its grounding eye to the related cable shield grounding device ground wire. Do not connect drain wires in any manner that will permit circulating currents, or cable fault currents, to pass through them.

Method of Measurement:

Transformers shall be measured for payment for work complete and accepted in place including all as specified below for each respective item.

Basis of Payment:

This work will be paid for at the contract unit price for "150 KVA PAD MOUNTED DISTRIBUTION TRANSFORMER" complete and accepted in place, which price shall include all materials including all electrical components, concrete slab foundation, conduits, conductors, circuit breakers, pull wire, grounding conductors, grounding loop, fittings, standoffs, and all equipment, tools, labor and work incidental thereto including all utility company charges.

This work will be paid for at the contract unit price for "750 KVA PAD MOUNTED DISTRIBUTION TRANSFORMER" complete and accepted in place, which price shall include all materials including all electrical components, conduits, conductors, circuit breakers, pull wire, grounding conductor & connection to grounding loop, fittings, standoffs, and all equipment, tools, labor and work incidental thereto including all utility company charges. The concrete slab foundation shall be paid for under the "ELECTRIC LOAD CENTER" item.

Conduit and wire between equipment will be paid as specified in the contract documents unless otherwise indicated in the details.

<u>Pay Item</u>	<u>Pay Unit</u>
750 KVA PAD MOUNTED DISTRIBUTION TRANSFORMER	EA
150 KVA PAD MOUNTED DISTRIBUTION TRANSFORMER	EA

ITEM #0202452A – TEST PIT

ITEM #0202455A – TEST PIT (ESTIMATED COST)

Description: Test pits shall be performed for determining the location of underground utilities in proximity of catenary foundations and high mast lighting. This work shall consist of the removal and satisfactory disposal of all materials, the removal of which is necessary for the proper completion of the work, at the locations shown on the plans or as ordered, and backfilling, all in accordance with these specifications.

Test pits shall also be in proximity of utility facilities to be located shall include pipes, conduits, duct banks, service connections, structures, tanks, utility appurtenances, and any miscellaneous items directed by the Engineer such as telltales/markers on the existing pipes, etc.

Construction Methods: Test pits shall be made in conformity with the requirements of the plans or as ordered by the Engineer. The Contractor shall furnish and employ such shores, braces, pumps, etc., as may be necessary for the protection of property, proper completion of the work and the safety of the public and employees of the Contractor and the Department. All bracing, etc., shall be removed when no longer required for the construction or safety of the work.

Wherever portions of existing full-depth bituminous concrete pavement are to be removed in conjunction with test pits, they shall be removed to neat lines. Where the limits of the areas in which such bituminous pavement is to be removed are adjacent to existing bituminous concrete pavement that is to remain in place, the limits shall be cut by a method approved by the Engineer.

Wherever portions of stone ballast is to be removed in conjunction with test pits, the stone ballast material shall be set aside separate from soils for re-use upon backfilling.

The size of the test pit shall be sized for the respective foundation.

The Contractor shall perform field surveys to establish the horizontal and vertical location and to document the type and size of the utilities at each test pit. The work shall be performed in accordance with the requirements of item “Construction Staking (Site 1)”. Contractor shall also take photos of utilities uncovered for project record and furnish the Engineer copies of all test pit data.

After the test pit is completed, the Contractor shall notify the Engineer. The test pit shall not be backfilled until directed by the Engineer. Upon Engineer acceptance, the Contractor shall package and provide a submittal of all test pit data, including field surveys, in accordance with contract requirements.

When backfilling is required, the material used shall be of a quality satisfactory to the Engineer and shall be free from large or frozen lumps, wood and other extraneous material. All backfill placed below subgrade shall be placed in layers of not more than 6 inches (150 millimeters) in depth after compaction and shall be thoroughly compacted by means of mechanical rammers or vibrators or by pneumatic tampers. Hand tampers shall be used only upon written permission of the Engineer. Unless otherwise ordered by the Engineer, the backfill shall be brought to the surface of the surrounding ground or subgrade and neatly graded.

All suitable material removed in making the excavation shall be used for backfill if required. All surplus or unsuitable material shall be removed and disposed of as directed. Should additional material be required for backfilling, it may be obtained from the Project excavation or from borrow pits, gravel pits, or elsewhere as the Engineer may direct.

Method of Measurement: Test pits for catenary foundations, and high mast lighting will be measured as each excavated, backfilled, surveyed, documented and accepted. There will be no separate measurement for mobilization and demobilization associated with this item.

Test pits for determining the location of underground utilities will be measured for payment under the item “Test Pit (Estimated Cost)” based on the actual work completed.

Basis of Payment: Test Pits for catenary foundations and high mast lighting shall be paid under the item “Test Pit” at the contract unit price each complete in place and accepted, which price shall include all materials, equipment, tools, surveys, and labor incidental thereto. The price shall also include backfilling, restoration of the ground & stone ballast where required and the disposal of surplus material. No additional payment will be made for shoring, bracing, pumping, and bailing or for material or equipment necessary for the satisfactory completion of the work. If “Granular Fill” is used for backfill, payment will be made at its respective contract unit price.

Test pits for determining the location of underground utilities shall be paid under the item “Test Pit (Estimated Cost)” as outlined under Article 1.20-1.09.04 – Extra and Cost-Plus work. The sum of money shown on the estimate and in the itemized proposal as “Estimated Cost” for this work will be considered the price bid even though payment will be made only for actual work performed. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figure will be disregarded and the original price will be used to determine the total amount for the contract. Payment will include all equipment, materials and labor associated with this item.

<u>Pay Item</u>	<u>Pay Unit</u>
Test Pit	EA
Test Pit (Estimated Cost)	EST

ITEM #0503471A - TURNOUT INSTALLATION
ITEM #0504010A - RAILROAD TRACK WORK

Description:

This work consists of required track survey work, furnishing and installation of all new timber ties, tie plates, rails, rail attachments, new turnouts, integration of new track construction with existing track and special trackwork including, but not limited to, furnishing and installation of new turnouts, and switches, others track appurtenances on a track subgrade, furnishing and installation of various systems of directly affixed track, final track aligning and surfacing, all within the limits of trackwork by Contractor as shown on the Contract Drawings.

Materials:

All materials necessary to construct the track structure shall conform to the American Railway Engineering and Maintenance-of-Way Association's (AREMA) Manual for Railway Engineering and the Metro-North Railroad Recommended Practice for the Inspection, Maintenance, and Construction of Track (MW-4).

1. **Owner-Furnished Materials** – Solar-Powered Switch Machines will be furnished and installed by MNR.
2. **Contractor Furnished Materials** - New 136 RE Head Hardened Rail and new No. 8 Turnouts will be furnished and installed by the Contractor. Contractor will deliver rail to New Haven Yard in 1,100 foot long strings, cut the rail as required and move the rail to the Contractor's work location. Location of storage will be finalized by MNR once a delivery date is established. The Contractor shall move the rail within the work site to the final installation location. The contractor has the option to furnish and install 80 foot long strings instead of 1,100 foot long strings and weld into CWR strings on site at no additional cost to the Project. The welding and testing shall meet the requirements of this specification for rail welding and production testing of thermite welds. The Contractor has the option to field weld the 80 foot long strings using flash butt welding and conduct testing by magnetic particle inspection techniques per AREMA MRE Specification, Chapter 4, Part 3, Section 3.10 and American Welding Society (AWS) Standards, AWS D15.2/D15.2M at no additional cost to the project. Turnouts will be furnished with all steelwork including switch point rails, stock rails, frog per AREMA Plan 641-03, guard rails, other turnout rails, standard and special work non-canted tie plates, joint bar assemblies; fastenings, OTM, and 9 foot switch ties. The switch portion of the turnout will be furnished panelized on 9 foot ties and with all other materials packaged. Turnouts will be stockpiled within the rail yard and shall be relocated to the installation site by the Contractor. All turnouts shall be fully assembled and inspected by a 3rd party inspection company prior to shipment from the manufacturer. All inspected track materials and related inspection reports shall be distributed to all parties.

3. **Contractor Furnished Materials** per AREMA and MNR MW4 and the following:

0300-0138

ITEM #0503471A, #0504010A

ADDENDUM NO. 3

- a. Crossties: New 7" x 9" x 8'-6" treated hardwood crossties per Metro-North Commuter Railroad Specifications for Cross Ties & Bracket Ties, attached to the end of this special provision.
- b. Switch Timbers: New 7" x 9" in lengths of 9', 10', 11', 12', 13', 14', 15' and 16' per AREMA and MNR MW-4 as required for turnouts shown in the Drawings.
- c. Tie Plates: Canted double shoulder for 6-inch base rail, new or relay, not less than 14-3/4-inches in length per AREMA. For use in existing track only.
- d. Spikes: New, 5/8" x 6" high carbon steel track cut spikes per AREMA. For use in existing track only.
- e. Joint Bars: New or fit, produced in matched pairs, standard six hole punching per AREMA Chapter 4, Part 3 Specifications for Quenched Carbon-Steel Joint Bars, Microalloyed Joint Bars and Forged Compromise Joint Bars, compatible with the rail provided by MNR and the existing rail at the connection points. Permanent bolted joints shall use new joint bars.
- f. Compromise Joints: New or fit, six hole forged steel compromise joints per AREMA. Permanent compromise joints shall use new joint bars.
- g. Bolt Assemblies: New, proper size for the rail and joint bars provided, per AREMA, SAE and ASTM standards. Standard joint bar bolts and nuts shall be heat treated carbon steel as per AREMA, with sulfur composition not exceeding 0.05%. Spring washers shall be in accordance with AREMA and ASTM F-436 (Standard Specification for Hardened Steel Washers Inch and Metric Dimensions).
- h. Rail Anchors: New or fit re-formed per AREMA. For use in existing track only.
- i. Elastic Rail Fastening Assemblies - All newly constructed track and turnouts shall use elastic rail fastening assemblies as follows:
 - 1) Tie Plates – New, Pandrol plates or a manufactured in USA and approved equal with 1:40 canted double shoulder design, not less than 16 inches in length, for new or fit second hand six-inch base rail with round holes for screw spikes. Plates can be rolled, punched, machined or forged. Plates shall be in accordance with AREMA and ASTM A67 (Standard Specification for Steel Tie Plates, Low-Carbon and High-Carbon-Hot-Worked).
 - 2) Elastic rail clips – New, Pandrol model “e”-2055 or a manufactured in USA and approved equal. For joint bars furnish either Pandrol “J” model clips or the Pandrol “C” clip assembly or approved alternative.

- 3) Screw Spikes / Coach Screws – New, Pandrol screw spikes and coach screws or a manufactured in USA and approved equal 15/16” diameter by 6” length per AREMA and ASTM A66 (Standard Specification for Steel Screw Spikes).
- j. Thermite Weld Kits: Furnish welding kits and all necessary tools and accessories to field weld all new rail joints and connections to existing rail from Orgo-Thermit, Inc., Railtech Boutet, Inc. or approved equal. Kits for compromise welds may be needed to connect to existing rails.
- k. Track Bumpers: Furnish new Type “WA” bumping posts as manufactured by Western-Cullen-Hayes, Inc. or a manufactured in USA and approved equal.

Submittals:

- A. Include in the costs for track construction the contractor shall prepare and forward submittals, with appropriate detail including manpower, equipment, material, superintendence, survey data, saleable drawings and schedule for any construction, including track construction, which CTDOT or its representatives may deem to impact upon the operations of the New Haven rail Yard or any other operating railroad or outside party. This submittal shall be known as the “Work Plan”. The contractor must take measures, at no additional costs to CTDOT, to comply with comments or directions given for the Work Plan by CTDOT or its representative.
- B. Rail operations in the New Haven yard may require construction during other than normal business hours including weekends, holidays, and night time. The contractor may be required by rail operations to construct track by means or methods other than normal common construction practices and these costs shall be included in the contractors bid price.
- C. Shop Drawings
 1. Submit layout plans showing rail types, continuous welded rail lengths, buffer rails, field welds, and detailed turnout plans.
- D. Work Plan
 1. Prepare and submit to the Engineer a general construction procedure to meet the trackwork requirements and tolerances listed herein. The work plan shall include the following description and sketches:
 - a. Construction sequence;
 - b. Material handling procedure (outline);

- c. Placement of Subballast;
- d. Placement of Ballast;
- e. CWR handling and installation; and
- f. Rail anchorage plan

E. Field Welding

1. Submit, prior to initiation of field welding, a detailed specification of proposed method and procedure for thermite or flash butt welding. Include name of manufacturer and manufacturer's requirements and details for the following:
 - a. Rail preparation;
 - b. Rail Spacing and tolerances;
 - c. Rail alignment;
 - d. Placing and bolting of molds;
 - e. Preheating rail, including temperature, method, and time;
 - f. Crucible tapping procedure, including of weld and cooling time;and
 - g. Trimming and grinding weld at red heat
2. Submit field welders' qualification certifications and certified laboratory test results for thermite or flash butt welding tests as specified herein.
3. Submit field weld record of all welds, as specified herein.

F. Samples

1. Submit samples of materials as required by the CTDOT or MNR.

G. Submit identity, location and classification of licensed incinerator and landfill facilities proposed for railroad tie disposal. Identified facilities must be approved by the

Authority prior to the commencement of the disposal process. The Engineer shall provide written notice to the Contractor of the suitability of the incinerator facility within 2 weeks (or 3 weeks, if DEP review is required) of the submittal by the Contractor.

- H. The contractor shall submit the name and number of the licensed hauler to the Engineer for review prior to removing the railroad ties off site. The Contractor shall provide the Engineer with a copy of manifest and certified weight slip for each quantity shipped, unloaded, and properly disposed of at the licensed facility.

Construction Methods:

Track installation shall comply with provisions of Specifications, Standards, and recommended practices of the most recent edition, and addenda thereto, of the AREMA Manual and the Metro-North MW-4.

The existing grade shall be leveled and compacted following the clearing and grubbing operation. Subballast and ballast shall be furnished and installed in accordance with the specifications and as shown on the plans or as directed by the Engineer.

Contractor will deliver rail to the rail yard and turnouts will be stockpiled within the rail yard ready for relocation, assembly and installation by the Contractor. Installation of ties, rail and turnouts shall proceed in a sequence approved by the Engineer to yield as little impact as possible upon yard operations.

Following final surfacing, all rail will be set to the neutral temperature specified in the MNR MW-4.

Installation and adjustment of Solar-Powered Switch Machines will be performed by MNR forces.

Surveying Requirements:

- A. Contractor shall maintain established control points and reference points for the duration of the Project.
- B. The identification and location of survey monuments are indicated on the Contract Drawings, including coordinates and elevations, for use by Contractor in establishing track geometry. Monuments damaged by Contractor will be replaced by the Engineer at the expense of Contractor.

- C. The Engineer may choose to relocate monumentation to accommodate as-built structure conditions. In case monuments must be relocated, they will be relocated by the Engineer at no expense to Contractor.
- D. The use of controls for survey other than the monumentation described above shall be at Contractor's risk.

Track Criteria

1. Gauge: Standard gauge of track shall be 4 feet 8-1/2 inches.
 - a. Gauge shall be measured with a standard track gauge. It shall be measured at right angles to rails between points 5/8 inch below top of rails. The Contractor's track gauges shall be checked at frequent intervals for accuracy.
2. Alignment, Grade, Super Elevation, Track Centers and Cross Level: Definitions are as follows:
 - a. Alignment: Horizontal location of track as described by curves and tangents. (Alignment shall be as established on the Drawings.)
 - b. Grade: Ratio of rise, or fall, of the grade line to its length. (Grade shall be as established by the profiles shown on the Drawings.)
 - c. Track centers: The distance between center lines of adjacent tracks, measured in a horizontal plane and at right angles to one of the tracks.
 - d. Cross Level: The difference in elevation of the tops of opposing rails of a track measured in a horizontal plane at right angles to the alignment.
3. Tolerances: Deviation from established gauge, cross level, profile grade and horizontal alignment shall not exceed the criteria specified.

<u>TRACK SURFACE AND ALIGNMENT</u>	<u>TOLERANCES</u>
a. Deviation from a true gauge of 4 feet – 8 ½ inches, measured at a plane 5/8 inch below top of rail on the inside face shall not exceed	1/8”
b. Gauge variation within 31 feet of track shall not exceed	1/8”
c. Total deviation from design horizontal alignment shall not exceed	1/2”
d. Deviation from alignment on either rail at the mid-ordinate of a 62 foot chord shall not exceed	1/4”
e. Total deviation from design profile shall not exceed	1/2”
f. Deviation from uniform profile on either rail at the mid-ordinate of a 62 foot chord may not exceed	1/4”

- g. Deviation from zero cross level shall not exceed 1/8"
- h. Cross level variation within 31 feet of track shall not exceed 1/8"
- i. Deviation from zero cross level at any two points less than 62 feet apart on tangents or curves may not exceed 1/4"

General Track Installation Procedures

1. Ballast which is located more than 4 inches below the final bottom of crosstie elevation will be known as “bottom ballast” and shall be placed and compacted prior to the construction of track. Ballast above that elevation shall be placed subsequent to the construction of skeleton track on the prepared bottom ballast.
2. Distribute and compact subballast and bottom ballast uniformly in layers not exceeding a compacted depth of 4 inches for each lift as per the cross sections in the Contract Drawings.
3. Thoroughly compact subballast and ballast until the stones are firmly interlocked and the surface is true and unyielding. Compact each lift with not less than four passes of a roller or a vibratory compactor subject to the following requirements:
 - a. Compact by rolling using a self-propelled roller of such weight that will provide compression of not less than 350 lb per linear inch of tread or roller.
 - b. Compact by vibration using vibration compactors of either the roller or pad type. Dynamic force for either type shall be not less than 20,000 lb and the frequency range shall be 1100 to 1500 vpm.
 - c. The compacting equipment selected by the Contractor shall be approved in advance by the Engineer.
4. Place timber ties normal to the centerline of track spaced at 19-1/2” on center so that the heartwood of the ties is down and the bottom surface of the ties have uniform bearing against the ballast. The ends of 8’-6” ties shall be brought to a uniform line, 18 1/2” from the edge of the base of rail on the line side. The line side shall be the northern side of the track in tangent and curved track and the straight side of each turnout. When placing ties care shall be taken not to damage ties with picks and spiking hammers. Tie tongs, lining bars, or other suitable tools or tie spacing equipment shall be used.
5. Install tie plates on the longitudinal centerline of each tie and place square to the centerline of the rail so that the outside shoulder of the plate bears fully against the rail base. Place plate with the downward cant toward the center of the track. Where using conventional tie plates and spikes, (in existing track only) rail shall be spiked with a minimum of two rail holding spikes and one plate holding spike (two spikes for curves

and within turnouts) per tie plate. Where using Pandrol plates, (to be used in construction of all new track) place one screw spike on the gauge side of the rail and one screw spike on the field side (place two screw spikes on both the gauge and field sides of the rail for curves and turnouts). Holes shall be pre-bored in the ties for the screw spikes.

6. Crosstie Replacement: Furnish and Replace defective crossties in existing tracks on approaches to new tracks work as directed by the Engineer. The Engineer will designate a maximum of 200 ties at each of the two track connections to be replaced concurrent with track installation.

7. Rail and Joint Bars:

- a. Rail joints shall be staggered by a minimum of 36" and configured as suspended joints so as to facilitate thermite or flash butt welding. When drilling bolt holes in the rail end, omit the end hole on each rail end and bolt-up six hole bars using only four bolt assemblies, leaving the joint in a condition suitable for thermite or flash butt welding. Permanent bolted joints at the ends of CWR strings shall have all six holes drilled and bolted.
- b. Outside of turnouts, the minimum length of rail allowed is 20 feet.
- c. Compromise joint bars shall be fabricated and installed in such a manner that any horizontal mismatch of rail ends is less than 1/16" and a vertical mismatch that is no greater than 1/16". The rail on existing Track 38 at the interface with new track and turnout installation shall be investigated by the Contractor in advance of ordering compromise bars. The new rail to be supplied by MNR will be 136 RE.
- d. If CWR strings are installed when the rail temperature is below 95 degrees Fahrenheit, rail neutral temperature shall be adjusted in accordance with procedures in the AREMA Manual and Metro-North's MW-4.
- e. When cutting rails, cuts must be clean and square using a rail saw or abrasive cutting disc only. Bolt holes shall be drilled. Hole locations shall be determined using a template or measured and marked to ensure correct hole location. Do not cut rails with a torch.
- f. All joints assembled by the Contractor shall be welded including connections to existing rails. Field welds shall be located at least 14' away from a field weld in the same rail, at least 4' from a plant weld in the same rail and at least 9-1/2" from a bolt hole. Field welding shall be completed as soon as track has been surfaced and aligned.
- g. The Contractor's methods shall minimize the number of rail cuts, shorter rail lengths and welds necessary to complete the work.

8. Rail Anchoring:

- a. Anchoring shall not proceed until the track has been sufficiently ballasted to prevent tie or track movement due to thermal expansion or contraction and until the track has been initially raised, tamped and aligned. Anchoring shall not proceed if the ambient temperature is less than 20 degree F. Anchors shall be applied flush to the side of the tie, on each rail with every other tie fully box-anchored. Anchors shall be omitted from at all locations where it is not possible

to install anchors on each rail such as joint bars. Drive-on type anchors shall be applied to switch stock rails, applied from the field side of the track. Care shall be taken in application of anchors so as not to interfere with switch rods. For strings of welded rail, every tie within 200 feet on each side of the rail joint at the end of the string shall be fully box-anchored and every tie within 200 feet of special trackwork and grade crossings shall be fully box-anchored.

- b. Omit rail anchors on tracks and turnouts constructed with Pandrol elastic rail fastenings.
9. Surface and align track by methods which will prevent undue bending of the rail, straining of joints or damaging rail fastening assemblies, and only after the cribs have been filled with ballast. No surfacing or aligning work shall be performed on track when the ambient rail temperature is greater than the temperature of the rail at the time it was anchored, nor less than 20 degrees Fahrenheit. Rail temperature shall be measured using a rail thermometer as specified in the current AREMA Manual, Chapter 5 by placing the rail thermometer on the shaded side of the rail base and leaving it in place for a minimum of five minutes or until there is no change in its reading.
10. When tamping ties, the ballast shall be thoroughly compacted under both sides of the tie from a point 15 inches inside of the rails to the ends of the tie. Do not tamp at the center of the tie outside of the limits indicated.
11. Final surfacing and aligning of the track and turnouts shall be in accordance with the geometries listed in the Contract Drawings. The final raise shall consist of a lift of no greater than 2 inches to bring the track surface to the final grade indicated on the Contract Drawings. Where tracks constructed by this contract connect to existing tracks, run out the surfacing into the adjoining tracks a distance as indicated by MNR's MW-4.
12. After the final surfacing and aligning of the track and turnouts, ballast shall be adjusted so that all cribs, excepting those beneath switch rails, are full. Leave the cribs open beneath switch rails and switch rods so that there is a minimum of 5 inches of clear space beneath them. Dress the ballast shoulder so that it extends beyond the ends of the ties of at least one foot horizontally in the plane of the top of tie at which point the shoulder may drop at a maximum rate of 2 horizontal to 1 vertical. Excess ballast shall not be left on top of the ties or timbers and shall not be allowed in flangeways or between stock rails and switch points. Final surfacing and alignment shall be within the tolerances listed in this specification.
13. Turnouts shall be installed in the same general manner as listed above in accordance with the geometric criteria in the Contract Documents. Survey is required to layout the Point of Switch, PITO and Point of Frog prior to installation and to be confirmed after completion of turnout installation. MNR will furnish and install switch machines and make final switch adjustments.

14. In order to determine the acceptability of the completed track and turnouts, the Engineer will verify that the track structure was constructed according to the Contract Documents. The Contractor shall submit appropriate scale reproducible final As built survey drawings of the trackwork for this verification. The As Built survey drawings shall indicate points on each rail at 50 foot stations as well as all points of curvature including tangent to curve, compound curve, curve to tangent points, points of vertical curves and tangents, start and end points, and all points of switch, PITO's and frog points. Drawings shall conform to the Connecticut General Statutes, Section 20-300b with a Horizontal Accuracy of A-1 and a Vertical Accuracy of V-2. Once verified, the Engineer will schedule MNR to make a final inspection to establish that the track and turnout construction is within the tolerances specified herein. The Contractor shall correct track deviations, as disclosed by the inspection, which exceed tolerances specified herein at no additional cost. The Contractor shall notify the Engineer two weeks in advance of the anticipated date(s) when the track will be ready for MNR inspections.
15. Install Track Bumpers at the locations shown on the Contract Drawings. Bumpers shall be installed per manufacturer's instructions and recommendations.

Rail Welding

- A. Welding shall be done in accordance with AREMA MRE Chapter 4, Part 3, Specification for the Quality Assurance of Thermite Welding of Rail or Specification for the Quality Assurance of Electric-Flash Butt Welding of rail and Specification for Fabrication of Continuous Welded Rail and MNR's MW-4, except as modified in these Specifications.
- B. Preparation of Rail Ends: Rail ends shall be either saw-cut or ground at right angles to the rail to provide a smooth and clean surface. The surface of the rails for a length of approximately 6-inches from the end of the rails shall be cleaned by grinding to remove all grease, dirt, loose oxide, oxidized metal, scale, and moisture. All burrs and lipped metal that would interfere with the fit of the mold shall be removed.
- C. Weld Gap: At the time of field thermite welding the rails shall have the rail gap recommended by the manufacturer of the weld kit and the approved welding procedures.
- D. Weld Alignment: Rail head shall be aligned to produce a weld which, with respect to alignment, shall comply with AREMA MRE and the following:
 - 1. The ends of the rails to be welded shall be properly gapped and aligned to produce a weld that shall conform to the alignment tolerances below. Alignment of rail shall be done on the head of the rail. The rail gap and alignment shall be held without change during the complete welding cycle.
 - 2. Vertical alignment shall provide for a flat running surface. Any difference of height of the rails shall be in the base.
 - 3. Horizontal alignment shall be done in such a manner that any difference in the width of heads of rails shall occur on the field side. Horizontal offsets shall not exceed 0.04-inch in the head and/or 0.12-inch in the base. If welding rails of a

different section, a mold shall be used that is custom-made for the rail sections to be joined.

- G. Surface Misalignment Tolerance: Combined vertical offset and crown camber shall not exceed 0.04-inch per foot at 600-degrees Fahrenheit or less. Combined vertical offset and dip camber shall not exceed 0.01-inch per foot at 600-degrees Fahrenheit or less.
- H. Gauge Misalignment Tolerance: Combined horizontal offset and horizontal kink camber shall not exceed 0.04-inch per foot at 600-degrees Fahrenheit or less.
- I. Thermite Weld Preheating: The rail ends shall be pre-heated prior to welding to a sufficient temperature and for sufficient time as indicated in the approved welding procedure to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld.
- J. Thermite Weld Cooling: The molds shall be left in place after tapping for sufficient time to permit complete solidification of the molten metal and proper cooling to prevent cracking and provide a complete weld with proper hardness and ductility.
- K. Weld Finish: Welded joints in the finished track shall be brought to a true surface and alignment by means of a proper grinding or planing machine (shear). Finish grinding shall be performed with an approved grinder operated by a skilled worker grinding evenly and leaving the joints in a smooth and satisfactory condition. The completed weld shall be finished by mechanically controlled grinding in conformance with the following requirements:
 - 1. The top and gauge side of the weld at the rail head shall be finished to within plus or minus 0.010-inch of the parent section. The bottom and sides of the rail base shall be finished to within 0.010-inch of the lowest rail.
 - 2. The remainder of the rail weld shall be finished to within plus 1/8-inch or minus 0.020-inch of the parent section. Finishing shall eliminate cracks visible to the unaided eye.
 - 3. Notches created by offset conditions shall be eliminated by grinding to blend variations. Protrusions and gouges in the welded area shall be removed, and the weld area shall be blended into the rail contour by grinding in a manner that will eliminate fatigue crack origins. Defects visible to the unaided eye shall be removed by grinding, except that if removal by grinding cannot be accomplished without damaging the rail, the weld shall be removed. Grinding pressure that would overheat the rail surface shall not be permitted.
 - 4. Heavy grinding or shearing of weld-up set metal shall be completed while the weld is still hot from welding.
 - 5. Welds produced by welding kits which are specially designed to produce reinforced welds need not be ground in the finishing area except as necessary to remove fins, burrs, cracks, etc.
- L. Weld Quality: Each completed weld shall have full penetration and complete fusion and be entirely free of cracks or fissures. Welds shall meet the acceptance criteria given in

American Welding Society D1.1 (Structural Welding Code-Steel). All welds shall be visually inspected at the time of welding. Inspect all thermite welds ultrasonically or flash butt welds by magnetic particle inspection techniques and as otherwise required by AREMA MRE.

- M. Weld Numbering: Semi-permanently mark a sequential weld number on the rail immediately adjacent to the weld using a quality lead paint marker at the time the weld is made. Welds shall be numbered sequentially in the order in which they are made. The Engineer will provide Contractor with the initial weld number. Defective welds that are replaced shall be assigned a new sequential number by adding a letter to the defective weld number (i.e. defective weld 347 would be replaced by 347A).
- N. Weld Recording: Record pertinent data on each field weld using the Record of Field Welds at the end of this Section or a similar form. Records of field welds shall be submitted to the Engineer on a weekly basis.

Production Testing of Thermite Welds

- A. All production thermite welds shall be visually and ultrasonically tested in the field for defects. All production flash butt welds shall be visually inspected and tested by magnetic particle inspection techniques in the field for defects. Testing shall be performed before the final track inspection. The testing shall be performed by a technician certified to have met American Society for Nondestructive Testing (ASNT) TC-1A (Personnel Qualification and Certification in Nondestructive Testing), Level II or III qualifications. Ultrasonic inspection of welds shall be performed in accordance with ASTM E 164 (Standard Practice for Contact Ultrasonic Testing of Weldments). Magnetic particle testing shall be performed in accordance with ASTM E 709 (Standard Guide for Magnetic Particle Testing). Visual testing will be in accordance with AREMA MRE.
- B. Ultrasonic Testing. Prior to testing of welds, the technician proposed for testing of thermite rail welds shall be certified in accordance with ASNT TC-1A, Level II or III and shall have at least one year's experience in testing for defects in rail.
- C. The following equipment shall be used for ultrasonic testing:
 1. Ultrasonic, pulsed echo, instrument normally used for inspection of rails with calibrated decibel gain control of minimum 2-decibel increments, operating in the range 1-5-MHz, with CRT screen and scale. Equipment shall be capable of detecting a 3/64-inch discontinuity 6-1/2-inches below top of rail.
 2. Calibrated paper tape recording attachments to record accurately the CRT screen indications when a non-complying weld is located.
 3. 2.25 MHz angle beam transducers 1/2-inch by 1-inch at 70-degrees and 45-degrees.
 4. Suitable high viscosity couplants of good wetting characteristics.

5. Standard IIW calibration blocks of rail steel for primary reference response and to construct distance-amplitude correction curve, and DSC blocks of rail steel for calibration checks.
 6. A "calibration rail" 18-inches long with a 3/64-inch diameter round bottom hole 6-1/2-inches below top of rail and in which other 1/8-inch diameter flat bottom hole patterns have been drilled as provided by Contractor.
- D. Incorporate the following in the test procedure:
1. Scanning level shall be plus 20-decibels minimum.
 2. Scan the rail in a zigzag pattern twisting probe, on one side of the weld only at a rate not exceeding 6-inches per second, so that the full weld is scanned. Each pass will overlap a minimum 10 percent and the scanning is carried out longitudinally to the rail.
 3. Calibrate the equipment at the start and end of each day's work, and at least every four hours during examination, and hourly checks with DSC blocks. If any point on the distance-amplitude curve has been changed by more than 20-percent, all results since last calibration check shall be void and all welds re-examined. If the curve has moved on the sweep line by more than five percent, all non-complying welds since last calibration check shall be re-examined.
 4. When a reflection of greater amplitude than the acceptance criteria is found, scan around the full perimeter of the weld from both sides, to ensure full weld coverage and determination of size, type, and location of discontinuity.
 5. Make permanent trace recording of discontinuity indications.
 6. Paint the rail web on both sides, across the weld, to denote weld not conforming to acceptance criteria.
- E. All welds shall be free from defect or flaw giving a reflected display of greater than 20-percent of distance-amplitude correction curve at calibration level, or will be as listed in Table 1.

TABLE 1 - MINIMUM ACCEPTANCE LEVELS (DECIBELS)					
WELD THICKNESS (in.)	5/16 - 3/4	3/4 - 1-1/2	1/2 - 2-1/2	1/2 - 4)	4 - 6)
TRANSDUCER ANGLE	70°	70°	70° 45°	70° 45°	70° 45°
REFLECTOR SEVERITY					
Large Reflectors	+8	+3	-1 +4	-4 +1	-7 -2
Small Reflectors	+9	+4	+1 +6	-2 +3	-5 0
Minor Reflectors	+10	+5	+3 +8	0 +5	-3 +2

- F. All welds shall also be visually inspected for surface cracks. Any welds with surface cracks shall be rejected.
- G. Use an ultrasonic test results reporting form that includes the location of the weld in track, the results of the ultrasonic inspection including size of defects found in the head, web or base of rail, shape identity and location of all reflections, trace record, the results of the visual inspection, name of inspector, and other information as needed.

Method of Measurement:

Turnouts will be measured for payment by the count of turnouts furnished and installed. One turnout includes switch ties, head block timbers, frog, switch points and stock rails, closure rails, and all throw rods. Each turnout unit shall be considered as beginning at the Number Zero tie ahead of the point of switch and extending to the Last Long Timber beyond the frog. Other track outside of that zone will be measured by the linear foot as indicated above.

Railroad Track Work will be measured for payment by the actual number of lineal feet measured along the centerline of track, installed and accepted excluding the length of turnouts. Track consists of two rails, connecting ties, bumping posts and all appurtenances. Where rail ends are staggered, the average of the two rail ends shall be used as the point of measurement.

The allotment of 400 ties to be furnished and installed as directed by the Engineer concurrent with track installation shall not be measured for payment, but shall be considered as incidental to the Railroad Track Work item.

Basis of Payment:

This work will be paid for at the contract unit price per “Each” for Turnout Installation which price shall include furnishing and installing turnouts complete in place including all materials, equipment, tools, and labor incidental thereto and “Linear Feet” for Railroad Track Work, complete in place, which price shall include all material, equipment, tools, welding, testing, and labor incidental thereto.

The cost for excavation below the finished grade of the track, backfilling, subballast, ballast and disposal of surplus material will not be paid under this section, but will be paid for under their respective contract items.

<u>Pay Item</u>	<u>Pay Unit</u>
Turnout Installation	EA.
Railroad Track Work	L.F

ITEM #0602052A – WELDED WIRE FABRIC – EPOXY COATED

Work under this item shall conform to the requirements of Section 6.02, supplemented and amended as follows:

Article 6.02.04 - Method of Measurement:

Add the following after 3. Welded Wire Fabric:

Welded Wire Fabric – Epoxy Coated will be measured for payment by the total area of the welded wire fabric installed and accepted. Splicing will not be measured for payment but shall be included in the cost of the work.

Article 6.02.05 - Basis of Payment:

Add the following after Welded Wire Fabric:

This work will be paid for at the Contract unit price per square yard for “Welded Wire Fabric – Epoxy Coated,” complete in place and accepted, including shop drawings, furnishing, fabricating and placing welded wire fabric and all materials, equipment, tools, labor and work incidental thereto.

Pay Item

Pay Unit

Welded Wire Fabric – Epoxy Coated

S.Y.

ITEM #0686200.15A - 15" POLYVINYL CHLORIDE PIPE – 0’ – 10’ DEEP
ITEM #0686200.24A - 24" POLYVINYL CHLORIDE PIPE – 0’ – 10’ DEEP

These items shall conform to the requirements of Section 6.86 of the Contract Specifications supplemented and amended as follows:

Article 6.86.01 Description:

Add the following:

This work shall also include the satisfactory testing of the gravity pipe.

Included in this item shall be the air testing of pipe.

Article 6.86.02 Materials:

Add the following:

Polyvinyl Chloride Pipe (PVC) and fittings shall conform to one of the following:

1. ASTM D3034: sizes up to 15 inches diameter
2. ASTM F679 – Pipe shall be solid wall pipe with a minimum stiffness of 46 lbf/in: sizes 18 to 36 inches diameter
3. ASTM F949 for corrugated PVC, smooth interior: sizes up to 36 inches diameter
4. AWWA C905: sizes up to 48 inches diameter
5. ASTM F1803 – Pipe shall be closed profile pipe with a minimum stiffness of 46 lbf/in: sizes 18 to 60 inches diameter. Closed profile pipe shall have a minimum stiffness of 46 psi for 18 inch to 27 inch diameter PVC pipe and minimum stiffness of 50 psi for 30 inch to 60 inch diameter PVC pipe.

The pipe shall have pipe diameter to wall thickness ratio (SDR) of a maximum of 35.

Pipe joints shall be sealed by high quality factory installed nitrile O-ring gaskets and shall conform to the requirements of ASTM F477.

Joints shall be the bell and spigot type subject to the approval of the Engineer. Joints shall be sealed with a nitrile "O" ring gasket, approved by the Engineer, and shall be of a composition and texture which is resistant to industrial wastes including oils and ground water, and which will endure permanently under the conditions likely to be imposed by this use. The joints shall conform to ASTM D3212.

The tensile strength shall be at least 1300 psi. The elongation at rupture shall be such that 2 inch gauge marks shall stretch to not less than 10 inch. Hardness shall be between 40 and 50, as measured with a Shore Durometer. The compression set (constant deflection) shall not exceed 25 percent of the original deflection.

The tensile strength after accelerated aging shall be not less than 80 percent of the original strength. The joint, when assembled, must be able to withstand a hydraulic pressure internally of at least 25 psi.

Fittings: Wyes, Tees, Bends and adapters, and any other fittings required by the Engineer shall be provided. Plans for such fittings showing cross sectional views with dimensions shall be provided, and the Engineer prior to their use shall approve such plans and fittings. The materials used in the manufacture of fittings shall conform with the requirements for the Pipe with which they shall be used and any variation of such requirements shall be subject to approval of the Engineer.

Testing: Pipe shall be tested when requested by the Engineer, and all sizes of pipe so designated shall be tested as follows:

Pipe shall be tested in accordance with ASTM D-2412 Standard Method of Test for External Loading Properties of Plastic Pipe by Parallel-Plate Loading.

Marking: Pipe shall be marked along the outside of the barrel in bold style type and shall indicate the manufacturer's name, pipe size, PVC compound used, i.e., PVC Type 1 Grade 1 and the ASTM material specification for the PVC compound used, i.e., ASTM D3034.

Workmanship: The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.

Waterstops: The manufacturer shall provide waterstops, acceptable to the Engineer, which shall be applied to the outside of plastic pipe when the pipe is to be enclosed in any structure where concrete or mortar is used which will prevent leakage along the outer wall of the barrel of the pipe.

Waterstops within each trench greater than 100' in length between structures are required and shall be Concrete Class "C" with no reinforcing.

Flexible Couplings: As required shall be manufactured by Fernco, Inc. Davison, Michigan or approved equal.

Article 6.86.03 Construction Methods:

Add the following:

Pipe Installation: Storm drain pipe shall be of the sizes, type, materials, etc., indicated by contract documents; all pipes shall be laid, supported, jointed, tested and backfilled as indicated or required for the particular job, location, or condition by drawings or other contract documents. All pipes when in place shall be precisely true to the line and grade indicated therefore by the Engineer, sound, well laid, jointed and bedded and free from defects. Any pipe discovered to be defective after having been laid shall be removed and replaced by a sound and satisfactory piece. All pipes shall be installed with a laser to assure close conformance to required grades.

All pipe shall be stored at the site until installation in a manner acceptable to the Engineer which will keep the pipe at ambient outdoor temperatures. Temporary shading shall be provided as required to meet this requirement. Simply covering the pipe or structures that allow temperature build up when exposed to direct sunlight will not be permitted.

Installation of PVC Pipe shall be in accordance with ASTM Specification D2321 and the following.

All pipes shall be installed per manufacturer's installation instructions.

Geotextile: The Contractor shall furnish and install Geotextile as called for in the contract drawings and in accordance with Article 7.55.

Bedding: Pipes shall be bedded in No. 6 Crushed Stone or as otherwise directed by the Engineer in accordance with the contract drawings and as described in of these specifications. Suitable bell holes shall be provided, so that after placement, only the barrel of the pipe receives bearing pressure from the supporting material.

All pipe and fittings shall be cleared of all debris, dirt, etc., before being installed and shall be kept clean until accepted in the completed work.

Pipe Straightness: No single piece of pipe shall be installed unless it is found to be generally straight. Such pipe shall have a maximum ordinate as measured from the concave side of the pipe not to exceed 1/16 inches per foot of length. If the deviation from straightness exceeds this requirement, then the particular piece of pipe shall be rejected for use until it can comply with this provision.

Before any joint is made, the previously installed unit shall be checked to assure that a close joint with the adjoining unit has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to the required grade by striking it with a shovel handle, timber or other unyielding object.

All joint surfaces shall be cleaned. Immediately before jointing the pipe, the bell or groove shall be lubricated in accordance with the manufacturer's recommendation. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. Suitable devices shall be used to force the pipe units together so that they will fit with a minimum open recess inside and outside and have tightly sealed joints. Care shall be taken not to use such force as to wedge apart and split the bell or groove ends.

Details of gasket installation and joint assembly shall follow the directions of the manufacturers of the joint material and of the pipe, all subject to review by the Engineer. The resulting joints shall be watertight and flexible.

Open ends of pipe and branches shall be closed with polyvinyl chloride stoppers secured in place in an acceptable manner.

After each pipe has been properly bedded, enough bedding material shall be placed between the pipe and the sides of the trench, and thoroughly compacted, to hold the pipe in correct alignment. Bell holes, provided for jointing, shall be filled with bedding material and compacted. Bedding above the spring line of the pipe (see Drawings for material) shall be placed and compacted to complete the pipe bedding.

The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench. At all times pipe installation is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs, or by other acceptable means.

If water is in the trench when work is to be resumed, the plug shall not be removed until suitable provisions have been made to prevent water, earth, or other substances from entering the pipe.

Pipelines shall not be used as conductors for trench drainage during construction.

Low Pressure Air Testing: Upon completion of installation, the Contractor shall provide certified air tests, as directed by the Engineer, on all pipes installed under this Contract.

Air testing will be conducted between structures. The pipe under test shall be plugged at both ends. An air hose shall be connected to a tapped plug to be used for air inlet to the line. The hose will be connected to portable air control equipment, which must include a shutoff valve, pressure regulating valve, pressure reduction valve and a monitoring pressure gauge with range from 0 to 5 psi.

Air shall be introduced from the air source through the control equipment to the pipeline.

- A. Introduce low pressure air into the sealed pipeline until the air pressure reaches 4 psi gauge greater than the average groundwater pressure.
- B. Allow a minimum of 2 minutes for the air pressure to stabilize to a minimum of 3.5 psi gauge greater than the groundwater pressure. Groundwater is assumed to be at ground surface unless the Contractor can prove by otherwise by test pitting.

- C. After the stabilization period, disconnect the air hose from the control panel to the air supply.
- D. The pipeline will be acceptable if the pressure decrease is not greater than 0.5 psi gauge in the time stated in the following table for the length of pipe being tested:

Time (Min.) for Length of Pipe

Pipe Diameter	0-99'	99-200'	200-300'	300-400'
4"	2.0	2.0	2.0	2.0
6"	3.0	3.0	3.0	3.0
8"	4.0	4.0	4.0	5.0
10"	5.0	5.0	6.0	8.0
12"	5.5	5.5	8.5	11.5
15"	7.0	8.5	13.0	17.0
18"	8.5	12.0	19.0	25.0
21"	10.0	17.5	26.0	35.0
24"	11.5	23.0	34.0	45.5
27" and larger	14.5	29	43.0	58.0

Test Results:

- A. If the installation fails the low pressure air test, determine the source of leakage.
- B. Repair or replace all defective materials and/or workmanship and repeat low-pressure air test at no additional cost.

Allowable Pipe Deflection: Plastic pipe provided under this specification shall be so installed in the ground that a deflection of no more than 5 percent can be anticipated. Such deflection shall be computed by dividing the amount of deflection (nominal diameter less minimum diameter when measured) by the nominal diameter of the pipe. However, between any two adjacent drainage structures, the average deflection shall not exceed 6 percent and no deflection at any point in the pipe shall exceed 7 percent, computed in the manner described herein.

Place Concrete Waterstops full width of trench from bottom of trench to 12" above pipe at the midpoint of each run that is greater than 100' between structures or as directed by the Engineer. Forms are not required however the Contractor may utilize them to restrain the width of the stop. A minimum width of 6" is required for each stop. Waterstops are not required for runs less than 100' between structures.

Detectable Warning Tape: Warning tape shall meet the requirement set forth in Standard Specifications Article 1.20-1.05.15 – Facilities Construction – Markings for Underground Facilities and comply with APWA color code requirements. Colored marking tape shall be labeled “**Caution Buried Storm Drain Line Below**”.

The warning tape shall be acid and alkali-resistant with a minimum tape thickness of 5.0 mils. Tape shall have a minimum strength of 5,800 psi, and a maximum 80 percent elongation.

Article 6.86.04 Method of Measurement:

Add the following:

Waterstops shall not be measured for payment.

Article 6.86.05 Basis of Payment:

Add the following:

Included in the unit price of the pipe shall be the cost of testing.

Included in the unit price of the pipe shall be all gaskets and waterstops.

PVC Pipe shall be paid for as “(Size) Polyvinyl Chloride Pipe”.

<u>Pay Item</u>	<u>Pay Unit</u>
15” Polyvinyl Chloride Pipe – 0’ – 10’ Deep	LF
24” Polyvinyl Chloride Pipe – 0’ – 10’ Deep	LF

ITEM #0728008A – 3/8” CRUSHED STONE

Work under this item shall conform to the requirements of Section 2.12, supplemented and amended as follows:

Article 2.12.01 - Description:

Add the following:

This item shall consist of 3/8” Crushed Stone used as a subbase where 3/8” Crushed Stone is indicated on the Contract Drawings.

Article 2.12.04 - Materials:

Add the following:

3/8” Crushed Stone shall conform to the requirements of CTDOT Form 817 Article M.02.02 for Subbase except that it shall meet Grading “C”.

Article 2.12.05 - Basis of Payment:

Add the following:

<u>Pay Item</u>	<u>Pay Unit</u>
3/8” Crushed Stone	C.Y.

ITEM #1108798A – CENTRAL COMMUNICATIONS EQUIPMENT

Description:

Work under this item shall include all labor, materials and services to install communication cables, fiber optic cables, copper pair and fiber optic terminations, pole hardware, and cabling services as indicated on the communications drawings.

Work under this item includes, but is not limited to, furnishing and installing aerial and underground communication cables from pole and/or existing and new manholes to buildings and yard telephones as specified and as shown on the site communications plans. The work also includes supporting appurtenances to support installation of the new outside plant cabling infrastructure.

The work shall include all materials, equipment and labor incidental for the completion of all work specified.

General:

The following shall be submitted by the Contractor:

Product Data: Provide manufacturer's literature and catalog cuts for communications cables, fiber optic cables, fiber optic terminations, and pole hardware.

Product Certification: Signed by manufacturer of product certifying that products comply with the specified requirements.

Color combinations for pair identification (communications cable).

Materials:

Fiber Optic Cable:

See Item #1113046A SINGLE MODE FIBER OPTIC CABLE, 6 FIBER, #1113047A SINGLE MODE FIBER OPTIC CABLE, 12 FIBER, #1113042A 144 STRAND SINGLE-MODE FIBER OPTIC CABLE, #1113043A 24 STRAND SINGLE-MODE FIBER OPTIC CABLE, and #1113055A SINGLE MODE FIBER OPTIC DROP CABLE

Communications Cable:

See Item #1113435A #22AWG 25 PAIR COMMUNICATION CABLE, #1113460A #22AWG 50 PAIR COMMUNICATION CABLE, #1113458A #22AWG 200 PAIR COMMUNICATION CABLE, and #1113459A #22AWG 300 PAIR COMMUNICATION CABLE.

Building Entrance Terminals (BET):

The building entrance terminals shall have combined protection and distribution with a built-in storage area for all unused cable pairs.

The protector modules shall protect against overvoltage and overcurrent.

The terminals shall be housed in a weatherproof galvanized steel enclosure with a gasketed hinged cover. The enclosure shall accommodate the quantity of conductor pairs indicated on the plans.

Provide a No.6 AWG solid copper ground wire and a 3/4 inch by 10 foot ground rod at each BET location.

Protectors:

Protectors shall be low noise, 5-pin gas-tube type with heat coils.

The protectors shall have vent-safe and fail-safe mechanisms to ensure automatic short to ground in the event of sustained or high current conditions.

Above Ground Splice Chambers:

Provide and install above ground splice chambers as indicated on the communications drawings.

Chambers shall be 6'x8' as manufactured by Precision Quincy Corp, XP Series, or approved equal, with appurtenances as shown on the communications drawings.

Provide and install foundations for each chamber as indicated on the structural drawings.

Provide interior electrical lighting fixtures and devices as indicated on the communications drawings. Service to supply panelboard will be provided via the cart garage.

Non Fusible Switch (exterior disconnect switches): NEMA KS 1, Type HD; 600 VAC, UL 98 listed, lockable handle.

- Equipment ground kit: Internally mounted and labeled for copper ground conductors.
- Neutral Kit: Internally mounted, insulated, capable of being grounding and bonded, and labeled for copper neutral conductors.
- Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.
- Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- Lugs: Mechanical type, suitable for number, size, and conductor material.
- Enclosure Type: NEMA 3R
- Labeled for use as service equipment

The electrical panelboard shall be a circuit breaker type and shall include both transformer primary and transformer secondary (panelboard main) circuit breakers. It shall be provided as a single factory assembled unit in a NEMA 3R enclosure suitable for exterior with wall surface mount preparation. The unit shall include both primary and branch circuit breakers as well as the minimum future space. The unit shall be UL listed.

The panelboards shall have a NEMA 3R ventilated enclosure hinged front cover. The interior panel cover shall be a hinged trim cover; secured with flush latch. The panel shall have bottom fed mains and tin plated copper phase, neutral and ground bars. Conductor connectors shall be mechanical type labeled for use with copper conductors. Provide the panel complete with all mounting brackets, bus connections, filler plates, and necessary appurtenances required for present and future installation of devices. The panelboard shall be fully rated at the short circuit rating indicated and provided with circuit breakers. The circuit breakers shall be molded case in compliance with UL489

Provide GFCI circuit breakers for any 120 VAC receptacle circuits.

Provide side mount surge protection device (SPD) with protection modes and UL 1449 Voltage Protection Rating (VPR) for grounded wye circuits with 208Y/120-V.

1. Line to Line: 1200V
2. Ground to Line: 700V

Provide interior power wiring to all devices and fixtures. Type XHHW wire shall be used for all power wiring, sized per the contract drawings.

Provide #6 insulated ground conductor from communication equipment rack and frames to ground bus bar.

Provide Rigid Galvanized Conduit for all interior conduit, sized per the contract drawings and conform to the requirements of Article M.15.09.

Wires and cables shall meet the same requirements as set forth in respective items in the contract.

Provide 1500W electrical heater. Electric heater shall be rated at 208V. Electric heater shall be wall mountable.

Provide two (2, one per circuit) 1800W (1920 VA) Uninterruptible Power Supply (UPS). The unit shall be UL listed and 19" rack mountable, compatible with the 19" equipment rack provided. UPS shall have a nominal output voltage of 120 volts sine wave at 60 Hz. UPS shall be provided with maintenance free sealed lead acid battery with suspended

electrolyte and leakproof. Output connections shall be (3) NEMA 5-20R, (1) NEMA L5-20R and (6) NEMA 5-15R receptacles. Transfer time shall 4ms typical and 8 ms maximum. Basis of design APC Smart UPS X 2000VA.

Fiber Optic Cable Splice Enclosure:

Provide and install fiber optic cable splice enclosure in above ground splice chamber as indicated on the communications drawings.

See ITEM #1112241A - FIBER OPTIC CABLE SPLICE ENCLOSURE

Communications Cable Splice Enclosure:

Provide and install communications cable splice enclosure in above ground splice chamber as indicated on the communications drawings.

Communications cable splice enclosures shall be Armadillo or approved equal.

Provide communication cable splice enclosure mounting struts and associated hardware, Unistrut or approved equal.

19" Equipment Rack:

Provide and install 19" equipment rack in above ground splice chamber as indicated on the communications drawings.

19" equipment rack shall have a minimum of 45rack units, and a minimum depth of 21".

19" equipment rack shall be Ortronics or approved equal.

Fiber Optic Patch Panel:

Provide and install fiber optic patch panel in above ground splice chamber as indicated on the communications drawings.

Fiber optic patch panel shall provide fiber management, connectivity, and distribution from a minimum of 144 fibers.

Fiber optic patch panel shall be Optical Cable Corporation RTS4U series or approved equal.

Type 66 Punch Blocks:

Provide and install type 66 punch blocks as necessary in above ground splice chamber as indicated on the communications drawings.

Type 66 punch blocks shall be Siemen S66M1-50 or approved equal.

All related type 66 punch block accessories (standoff brackets, covers, etc.) shall be of the same manufacturer as, and expressly compatible with supplied type 66 punch blocks.

Main Distribution Frame:

Provide and install main distribution frame in above ground splice chamber as indicated on the communications drawings.

Main distribution frame shall be Emerson 25007FRAME2 or approved equal.

Main distribution frame shall be equipped with mounting brackets, and shall be Emerson 2500MB or approved equal.

Main distribution frame shall be equipped with cable through guides, and shall be Emerson 2500CT or approved equal.

Miscellaneous Hardware:

Provide and install miscellaneous hardware in above ground splice chamber as necessary.

The contractor shall provide J Mod Cable Support System (J Hooks), Panduit or approved equal.

The contractor shall provide black Velcro 8" tie wraps as necessary, Panduit HLT21-X0 or approved equal.

Construction Methods:

The Contractor shall install materials in accordance with the manufacturer's instructions and as shown on the plans.

Method of Measurement:

The work will be measured per each, as applicable, complete in place and accepted.

All Conductors, Cable, panelboards, SPDs, UPSs, electrical receptacles, electric heaters, and RGS Conduits with hangers and hardware interconnecting equipment associated with the above ground splice chamber will not be measured for payment, but the cost shall be considered as included in the bid price.

Pole and manhole hardware work will be considered incidental to the work of this Special Provision, and will not be measured as a separate item.

Basis of Payment:

The work will be paid for at the respective contract unit price.

The cost of pole and manhole hardware work will be considered incidental to the work of this Special Provision.

Items that are not paid for under the Central Communications Equipment item are:
Fiber Optic Cables, Communications Cables, and Fiber Optic Cable Splice Enclosure

The prices shall include all costs to provide for the completion of the work specified and shown on the site communications plan drawings.

<u>Pay Item</u>	<u>Pay Unit</u>
Central Communications Equipment	Ea.

ITEM #1108873A – NETWORK VIDEO RECORDING (NVR) SYSTEM
ITEM #1112227A – FIXED MOUNT CAMERA DOME

Descriptions:

This work shall consist of furnishing and installing Fixed Closed Circuit Television (CCTV) dome camera assemblies, camera mounting devices, and other items at the field locations shown in the Plans and in accordance with the Contract Documents.

Materials:

All materials furnished, assembled, fabricated, or installed shall be new, corrosion resistant and in strict accordance with the details shown in the contract documents. The CCTV Dome Cameras and other items shall be fully compatible with each other and shall have the capability of being fully controlled by software and hardware being furnished under other Contract items. All cameras shall be fully compatible with the existing Verint Nextiva Video Management System at CCO Shop and T&E Building, and with the existing Pelco Digital Sentry Network Video Recorder at CCO Shop. The contractor shall be responsible for attaining new additional licenses for the Pelco Digital Sentry Network Video Recorder.

General Requirements:

The equipment shall deliver high quality full-motion video during day or night operation with the video transmitted over fiber optic networks installed as part of this project as indicated in the Contract Documents.

Cameras shall be IP-based and comply with established network and video standards. Cameras shall be powered by the network switch utilizing the network cable as shown on the Contract Drawings. Power injectors (midspans) are not acceptable unless specifically shown. Cameras shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications and ONVIF compliant.

Mounting hardware be provided as part of these Items. The camera assembly shall be designed for mounting on a pole, structure, or wall as specified in the contract documents. Adapter plates, where required, shall be provided as part of these items. Connections between the equipment shall be through weather proof connectors to provide easy replacement. All cabling to the cameras shall be in conduit. Servicing of the camera assembly shall be available in the continental United States or Canada.

All conduits, cabling, hardware and other items not specifically called out elsewhere in the Contract Documents that are required for a complete and fully functioning Fixed CCTV Dome Camera as described in the Specifications and Contract Documents shall be provided by the Contractor as part of these Items.

Network Video Recording (NVR) System Requirements

The network video recording system (NVR) system shall be Pelco model DSSRV2-240RD meeting the following requirements:

- A. 300 Mbps to support IP and analog video.
- B. Supports up to 128 IP camera streams; up to 64 analog cameras.
- C. Optimized to support pre-installed DS NVs software.
- D. Records H.264, MJPEG, and MPEG-4 IP streams.
- E. Supports Pelco and Third-Party IP cameras and network encoders.
- F. Expandable by networking an unlimited number of servers and encoders (dependent on available network bandwidth).
- G. Compatible with DS control point for simultaneous monitoring of all DS series and DX series products in a single client interface.
- H. Network health and event monitoring support through Simple Network Management Protocol (SNMP) and new Digital Sentry System Information (DSSI) Utility.
- I. Provide and install video storage system capable of storing video from all cameras shown on the Contract Drawings at a resolution of 1080p at 15 frames per second for 30 days.
- J. Provide new Pelco NVR licenses for the new CCTV cameras, and 10% spare NVR licenses.

Fixed Mount Camera Dome Requirements

The fixed mount camera dome shall be Axis model Q3515-LVE (see source limitations below) meeting the following requirements:

Camera Image Sensor: 1/2.8” Progressive Scan RGB CMOS
Lens: Varifocal, Remote focus & zoom, IR-corrected, P-iris control

Focal Length Options:

3-9 mm, 105°-36° (horizontal), F1.3

Camera shall have the option of a 9-22mm lens, 36°-15° (horizontal), F1.6. Final lens selection shall be coordinated with field conditions.

Zoom:	3-9 mm: 3x (optical); 2x (digital) 9-22 mm: 2.4x (optical); 2x (digital)
Minimum Illumination:	3-9mm: Color: 0.07 lux at 50 IRE, F1.3 (1080p, 30fps, with WDR) B/W: 0.01 lux at 50 IRE, F1.3 (1080p, 30fps, with WDR) 9-22mm: Color: 0.11 lux at 50 IRE, F1.3 (1080p, 30fps, with WDR) B/W: 0.02 lux at 50 IRE, F1.3 (1080p, 30fps, with WDR)
Day/Night: filter	Automatically removable infrared-cut
Shutter Time:	1/66500 s to 2 s
Video Compression:	H.264 (MPEG-4 Part 10/AVC) Motion JPEG
Resolutions:	1920x1080 to 160x90
Frame Rate:	Minimum 30fps with WDR at 1080p resolution.
Video Streaming:	Multiple, simultaneous, individually-configurable H.264: Baseline, Main, and High profiles Motion JPEG The camera shall support both Maximum Bit Rate (MBR) and Variable Bit Rate (VBR) in H.264 and provide configurable compression levels.
Supported Protocols:	IPv4/v6, TCP, UDP, NTP, RTSP, HTTP, HTTPS, SSL/TLS, FTP, SMTP, DNS, SOCKS,
SSH, RTP, RTSP, DHCP	
Camera ID:	Up to 20 characters (alphanumeric characters, marks)
Network Interface:	10Base-T/100Base-TX PoE, RJ-45 connector
Inputs and Outputs:	2 configurable I/O ports, accessible via terminal block. Configurable normally open or normally closed
Power:	Power over Ethernet (PoE) 802.3af, 12.5W max.
Memory:	1 GB RAM, 512 MB Flash
API:	Open API for software integration ONVIF Profile S
Event Triggers:	Analytics, Supervised external inputs, Edge storage events, Shock detection
Image Settings:	Electronic image stabilization, white balance, backlight compensation, image rotation (90 degree increments), low

	light compensation, exposure control, privacy masks
Video Transmission:	HTTP (Unicast), HTTPS (Unicast), RTP (Unicast & Multicast), RTP over RTSP (Unicast), RTP over RTSP over HTTP (Unicast)
Environmental:	-40°C to +60°C (-40°F to +140°F), 10-100% RH (noncondensing)
EMC Approvals:	FCC Part 15 - Subpart B Class
Railway EMC Approvals:	EN 50121-4, IEC 62236-4
Information Technology:	IEC/EN/UL 60950-22 (Outdoors)
Vibration/Shock:	IEC 60068-2-6/IEC 60068-2-27
MTBF:	>100,000 hours

The camera shall be an outdoor, vandal-resistant network dome camera designed for 24/7/365 use. The enclosure shall include a polycarbonate and aluminum body with encapsulated electronics, weather shield for vertical installations, and meet the requirements of IEC/EN 60529 IP66/67, NEMA 250 Type 4X, and IEC/EN 62262 IK10+ (50 J). Enclosure shall provide the ability to adjust the camera modules angle with 0° to 90° tilt, $\pm 360^\circ$ pan and $\pm 95^\circ$ rotation while maintaining an image that is not interfered by the camera housing. Enclosure shall be equipped with a dehumidifying membrane.

The camera shall feature a black and white mode that may be automatically engaged on low light level and permit the use of an external infrared illuminator or manually selected. The camera shall incorporate independent automatic color-to-black and white switching modes for switchover on light threshold and sensitivity to IR illumination. Automatic color-to-black and white switching shall have selectable light level thresholds (high or low) and duration settings for the selected threshold before automatic switchover occurs.

Outdoor pendant adaptor kit (Axis T94M01D or as required to match camera and mounts furnished) shall be included.

Camera source limitations: Cameras shall be of sole brand, Axis, as determined for the operational and maintenance needs of Metro-North Railroad. Model number substitutions will be considered for newer models that meet or exceed the technical requirements herein. All substitutions shall be fully coordinated with the overall design by the Contractor. In the event the cameras listed are determined to be end-of-life, or near end-of-life, the Contractor shall propose an alternate that satisfies the technical requirements within. All cameras shall be fully compatible with the existing Verint Nextiva Video Management System and the existing Pelco Digital Sentry Network Video Recorder.

Product Data: Submit Manufacturer's literature and catalog cuts for all products/materials to the Engineer for review and approval.

Contractor shall ensure all substitutions are coordinated with the design and the installation conforms to all Contract requirements and local codes.

Construction Methods:

The plans indicate the extent and the general location and arrangement of the work. The Contractor shall study the plans and details so that the work will be properly located, readily accessible, and with the best possible view. If conflicts occur necessitating departures from the plans, the Contractor shall submit details of departures and reasons therefore shall be submitted as soon as practicable for written approval of the Engineer. Contractor shall ensure any rerouting required does not adversely affect the communications circuits.

Contractor shall survey all camera locations and provide a mounting detail for the mounting method for the cameras. Mounting details shown on the Plans are typical and will require variations based on site conditions. Provide brackets to support camera installation location. Provide manufacturer recommended pads and/or vibration dampeners at locations subject to high winds and other vibrations. The detailed mounting design shall be approved by the engineer prior to the start of work. No items shall be attached to catenary poles unless specifically shown on the Plans and subsequently approved in shop drawings.

Pre-Installation:

Prior to installation, a field of view survey shall take place that includes but is not limited to, each camera location, lens setting, and mounting type shall be field confirmed by generation of a still image (screen shot from a camera and lens configuration identical to that submitted - on a pole, with laptop to capture a picture of the field of view) to be submitted for approval before the camera mount and conduit is installed at each location. Contractor shall provide the Engineer at least two (2) weeks' notice prior to performing surveys to allow Department or Railroad personnel to attend at their option. Coordinate camera locations and field of views with all obstructions such as signage, speakers, lights, poles, catenary structures, etc.

Contractor shall be responsible to furnish all equipment required for the surveys described above. Such equipment shall remain property of the Contractor. Equipment loaned from the camera manufacturer is acceptable, if available.

Make field inspections necessary in order to prepare accurate shop drawings in accordance with existing conditions and approved field of views. Submit shop drawings coordinated with existing conditions and all other work for approval prior to performing any installation. Note any nearby obstructions that could impact the field of view. Include plans, elevations, sections, details, and attachments as needed. Drawings should indicate site specific installation details including showing the exact equipment locations, mounting details, riser diagrams, mounting heights, distance from edge of platform, and side of pole (where pole mounted).

Installation:

Contractor shall verify all field conditions, ensuring no new obstructions are present. If new obstruction affects the camera view, immediately notify the Engineer.

Camera installation and Field of View adjustment: All cameras shall be located, position confirmed, rotated, and calibrated to provide for optimal fields of view.

Camera Housings and Mounts:

A. General Requirements for Camera Housings and Mounts

1. Furnish a complete mount for every camera being furnished and installed under this Contract. The mount shall be designed for use with the camera, and for conditions at the installation location. Camera mounts and mounting method shall be rated for heavy duty and be of sturdy construction. It shall be suitable for indoor and outdoor applications, and have an appearance which matches the surrounding area. The mount shall be made of steel, unless otherwise noted, and painted to match the surrounding area as approved by the Engineer. All hardware shall be tamper resistant. Furnish all accessories required for a complete installation.
2. Furnish conduit adapters and related items as required.
3. Furnish smoked domes where shown on the Contract Drawings.
4. Where indicated on the plans, furnish and install an outdoor pole mount bracket. Where attached to poles, mount shall not extend past the edge of the pole. Coordinate attachments to new poles with pole manufacturer. Submit mounting/attachment details for approval. Wall mount shall be AXIS T91E61 or approved equal. Wood pole mounted camera will require pole mount adapter, and shall be AXIS T91B47 or approved equal.
5. Plug all unused openings in accordance with manufacturer instructions.
6. All cameras and other devices, mounts, etc. shall maintain at least 6'-8" clearance above finished floor.

Environmental:

Wind: Meet all performance requirements when subjected to a 90 mph wind and able to withstand a 127 mph wind.

Documentation

Six (6) advance copies of equipment manuals furnished by the manufacturer shall be submitted to the Engineer for review at least ten (10) days prior to the scheduled start of the first Stand- Alone Test. The Engineer will verify the manufacturer's equipment manual as part of the test and integration process. The equipment manual incorporating the Engineer's corrections and comments shall be integrated by the Contractor into the operations and maintenance manual as

described in the contract documents. The manuals shall, as a minimum, include the following:

1. Complete and accurate schematic diagrams.
2. Complete installation and operation procedures.
3. Complete performance specifications (functional, electrical, mechanical and environmental) of the unit.
4. Complete list of replaceable parts including names of vendors for parts not identified by universal part numbers such as JEDEC, RETMA or EIA.
5. Complete maintenance and troubleshooting procedures.
6. Setup and configuration data for each camera location including the camera address, day/night threshold setting, horizontal and vertical limit settings and shutter speed.

Contractor shall use a GPS device to locate all devices at their final installation location. Furnish all GPS coordinates to the Engineer in Microsoft Excel format, along with a complete device schedule to include location description, device ID, mounting type, direction, preset locations, and all other descriptive information.

Upon completion of the installation and testing, prior to acceptance, thoroughly clean (internally and externally) all equipment furnished and/or installed under these Items.

Testing:

Prior to purchase of the proposed CCTV camera, contractor shall test the compatibility of the cameras with the existing VMS. At a minimum, the following shall be included: verification of proper installation of equipment per approved drawings and manufacturer recommendations.

Method of Measurement:

The Network Video Recording (NVR) System and Fixed Mount Camera Dome will be measured for payment as the number of “Each” satisfactorily furnished, installed, tested and approved by the Engineer.

Basis of Payment:

The unit price bid for each Network Video Recording (NVR) System and Fixed Mount Camera Dome shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work including testing.

<u>Pay Item</u>	<u>Pay Unit</u>
Network Video Recording (NVR) System	Ea.
Fixed Mount Camera Dome	Ea.

ITEM #1112302A – ACCESS CONTROL SYSTEM

Description:

The Contractor shall furnish and install Access Control System at the locations as shown in the Plans and shall furnish the spare parts listed in this specification.

Materials:

It shall be the responsibility of the Contractor to coordinate the purchase and delivery of this equipment with the Engineer, and MNR Communications to guarantee the most recent version/models are being purchased. It shall also be the responsibility of the Contractor to purchase all necessary components, pieces, parts, modules, cabling, software, licenses, and configuration in addition to the parts specifically mentioned above to provide a complete and fully-functioning system as described in these Special Provisions, Plans, and elsewhere in the Contract Documents. Configuration and testing shall be performed by the Contractor.

Proximity Card Access Reader Requirements

The Proximity Card Access Readers shall be configured with the requirements as outlined in this Specification.

The proximity card reader shall be HID RP40 meeting the following minimum requirements:

- A. The card reader shall be a proximity card reader utilizing proximity cards, or key fob/tag.
- B. It shall be equipped with a tamper switch and have a fully weatherized casing shell. It shall be equipped with colored LED's for reader status.
- C. It shall be designed to operate on 12 VDC.
- D. Proximity card reader parameters:
 - 1. Read range: 4.25 inches.
 - 2. Compatible with Wiegand Lenel access control systems.
 - 3. Industry standard Wiegand (26 to 56 bit) output.
 - 4. Transmitting frequency: 13.56 MHz and 125 kHz.
 - 5. Complies with FCC Part 15, UL 294, UL 94.
 - 6. Cable distance: Wiegand/clock and data interface 500 feet (18 AWG NFPA 70, Type CMP).
 - 7. 125 kHz card compatibility: HID Prox and AWID credentials.
- E. It shall have an operating temperature range of -35° to $+65^{\circ}$ C.
- F. Furnish card readers in the required quantities as indicated in the SEC series drawings.

All new card readers shall be compatible with the existing proximity type card currently in use at the New Haven Yard.

- G. Furnish power supplies as required and wall plate for each card reader unit.
- H. Furnish all card readers with required back boxes/plates and, for outdoor installation, weather shields.

Intelligent System Controller Requirements

The Intelligent System Controller shall be configured with the requirements as outlined in this Specification.

The intelligent system controller shall be Lenel LNL-3300 meeting the following minimum requirements:

- A. The intelligent system controller shall provide full distributed processing of access control, alarm reporting and remote control operations. It shall be capable of supporting the required numbers of dual reader interface modules, input control modules and output control modules.
- B. The controller shall be equipped with flash memory for real-time program updates, feature anti-pass back capabilities, and have dedicated inputs for tamper and power-failure status.
- C. It shall be designed to operate on either 12 or 24 VDC.
- D. It shall be capable of communicating with the host computer in a single path or dual path configuration of Ethernet, dial-up or direct connect communications (RS-232/485). It shall be equipped with a dual Ethernet card for Ethernet communication.
- E. It shall have a minimum of 15 MB on-board memory.

Dual Reader Interface Module Requirements

The Dual Reader Interface Module shall be configured with the requirements as outlined in this Specification.

The dual reader interface module shall be Lenel LNL-1320 meeting the following minimum requirements:

- A. The dual reader interface module shall be capable of supporting two card reader units. It shall have eight inputs that support normally open, normally closed, supervised, and non-supervised circuits. It shall have six output relays to support normally open or normally closed operation.

- B. It shall be designed to communicate directly with the Intelligent System Controller either by 2-wire RS-485 or 4-wire RS-485 communication and have dedicated inputs for tamper and power-failure status.
- C. It shall provide door contact supervision (open/closed); it shall provide REX push-button monitoring and strike control output.
- D. It shall be designed to operate on either 12 or 24 VDC.

Power Distribution Module Requirements

The Power Distribution Module for the intelligent system controller and dual reader interface modules shall be configured with the requirements as outlined in this Specification.

The power distribution module shall be Altronix PD4ULCB or equivalent meeting the following minimum requirements:

- A. Input Power: 24VDC.
- B. Input Current: 10A.
- C. Number of Outputs: 4 PTC protected Class 2 Rated power limited outputs (auto-resettable).
- D. Output Current: 2A per output maximum.

Multi-Output Access Power Controller Requirements

The Multi-Output Access Power Controller shall be configured with the requirements as outlined in this Specification.

The multi-output access power controller shall be Altronix ACM8CB or equivalent meeting the following minimum requirements:

- A. Input Power: 24VDC.
- B. Input Current: 10A.
- C. Number of Outputs: 8 independently controlled PTC protected Class 2 Rated power limited outputs (auto-resettable).
- D. Output Current: 2.5A per output maximum.
- E. Number of Trigger Inputs: 8 access control system trigger inputs

24 VDC Power Supply Requirements

The Power Supplies for the power distribution module and multi-output access power controller shall be configured with the requirements as outlined in this Specification.

The power supplies shall be Phoenix Contact 2904601 or equivalent meeting the following minimum requirements:

- A. Power supply shall have an input voltage range of 100 to 240VAC.
- B. Power supply shall provide a 24 VDC output.
- C. Power supply shall provide 10A maximum output.
- D. Power supply shall have an operating temperature range of -25° to $+60^{\circ}\text{C}$

Door Contacts Requirements

The Door Contacts shall be configured with the requirements as outlined in this Specification.

The door contacts shall be Sentrol 2757/2767/2507A or equivalent meeting the following minimum requirements:

- A. Door Contacts shall be wide gap, surface, or flush mounted.
- B. Maximum Input Voltage: 50 VDC.
- C. Maximum Input Current: 500mA.

Crash Bar Requirements

The Crash Bar shall be configured with the requirements as outlined in this Specification. The crash bar shall be suitable for door width of 36" and mounted at 41" from finished floor to centerline of crash bar.

The crash bar shall be Yale 7100(F) Rim Exit device with electrified trim Yale 691F or equivalent meeting the following minimum requirements:

- A. Integrated request to exit.
- B. Latch monitoring.
- C. Release via key operation or from access control system.
- D. Material: Stainless steel.
- E. Voltage: 24 VDC
- F. Current Draw: 330mA.

Electric Power Transfer Hinge Requirements

The Electric Power Transfer Hinge shall be configured with the requirements as outlined in this Specification.

The electric power transfer hinge shall be McKinney T4A3386 QC4 or equivalent meeting the following minimum requirements:

- A. (2) Circuit power transfer hinge.
- B. 28 AWG multi-strand wires.
- C. Material: Stainless steel.
- D. Voltage: 24 VDC.
- E. Current Draw: 4A.

#22 AWG, 1 Pair Communication Cable Requirements

The #22 AWG, 1 Pair Communication Cables shall be Belden or equivalent meeting the following minimum requirements:

- A. Fluorinated ethylene propylene-Jacketed, Paired, 1 pair, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated ethylene propylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
- C. Flame Resistance: Comply with NFPA 262.

#22 AWG, 2 Pair Communication Cable Requirements

The #22 AWG, 2 Pair Communication Cables shall be Belden or equivalent meeting the following minimum requirements:

- A. Fluorinated ethylene propylene-Jacketed, Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated ethylene propylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
- C. Flame Resistance: Comply with NFPA 262.

#18 AWG, 2 Pair Communication Cable Requirements

The #18 AWG, 2 Pair Communication Cables shall be Belden or equivalent meeting the following minimum requirements:

- A. Fluorinated ethylene propylene-Jacketed, Paired, 2 pairs, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated ethylene propylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
- C. Flame Resistance: Comply with NFPA 262.

#18 AWG, 3 Pair Communication Cable Requirements

The #18 AWG, 3 Pair Communication Cables shall be Belden or equivalent meeting the following minimum requirements:

- A. Fluorinated ethylene propylene-Jacketed, Paired, 3 pairs, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated ethylene propylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
- C. Flame Resistance: Comply with NFPA 262.

Licenses

Furnish and install all required system licenses, with a minimum of 10% spare, along with any additional system configuration and administrative task required to provide a fully functional access control system. This task may include, but is not limited to, operating software updates/patches.

Construction:

Prior to purchase, the Contractor shall submit a complete parts list and “Bill of Materials” (BOM) for approval by the Engineer.

The Contractor shall submit shop drawings for installation to the Engineer, 10 calendar days prior to installation, and shall be approved by the Engineer. A complete list of all components, pieces, parts and modules being supplied shall be submitted to the engineer for approval. The proximity card reader shall be installed to meet ADA requirements. Proximity card reader shall be installed to keep and create a unit approved for outdoor use.

Testing:

At a minimum, the following test shall be included: verification of proper installation of equipment per approved drawings and manufacturer recommendations.

Method of Measurement:

The Access Control System shall be measured for payment as “LS” for the actual number of listed items in this specification and furnished, installed, tested, and accepted.

Basis of Payment:

The work under this item shall be paid for at the contract unit price per lump sum including components all furnished, installed, tested, and accepted, which price shall include all material,

spare parts including delivery, tools, equipment, labor, and work incidental thereto.

Pay Item

Pay Unit

Access Control System

L.S.

ITEM #1204252A – SERVICE CONSOLE

ITEM #1204253A – SERVICE CONSOLE PIPING

ITEM #1204254A – CLEANING CABINET

Description:

Scope

Work under this section includes furnishing and installing service consoles, cleaning cabinets and service console piping as indicated on the plans.

Service consoles include non-potable hydrants, sanitary hoses, concrete pad/foundations, bollards, geotextile, crushed stone, subbase, processed aggregate base, and associated accessories.

Cleaning cabinets include a prefabricated base/foundation, a water heater, a soap dispenser, internal plumbing, sewer & water assemblies, heat trace, non-fusible switches, other miscellaneous electrical components and provisions for power, lighting, and cleaning agents. Also included under this item are bollards, geotextile, crushed stone, subbase, and processed aggregate base.

Service console piping includes all necessary piping, cleanouts and connections to the sanitary laterals.

Related Work

Related requirements are included in, but not limited to, the following:

1. 600 Volt Copper Wire Items
2. RGS Conduit in Trench Items
3. Polyvinyl Chloride Pipe (Sanitary Sewer) Items
4. Service Connection (Water) Item
5. Geotextile (Separation - High Survivability) Item
6. Steel Bollard Item

Submittals

Submit the following in accordance with the Standard Specifications Article 1.20-1.05.02:

- A. Shop Drawings:
 1. Sufficient information, clearly presented, shall be included to determine compliance with Plans and Specifications.
 2. Include electrical ratings, impedance, dimensions, weight, mounting details, plumbing details, connection diagrams, and accessories.
 3. Complete nameplate data including manufacturer's name and catalog number.

B. Manuals:

1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts. Reviews will be based on complete submissions of manuals together with shop drawings.
2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operation manuals to the Engineer.
 - a. Update the manual to include any information necessitated by shop drawing approval.
 - b. Include information for testing, repair, trouble shooting, assembly, disassembly, and recommended maintenance intervals.
 - d. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
 - e. Furnish manuals in loose-leaf binder or manufacturer’s standard binder.

C. Product data: Submit product data for pipes, hardware, adapters, cabinets, bases, receptacles, and identification devices.

D. As-Built Drawings: The Contractor shall field verify sewer profiles and crossings and submit as-built drawings at the end of the job.

Materials:

Pipe and pipe fitting materials shall be compatible with each other.

Service Console

Concrete shall be Class “F” meeting the requirements of Article M.03.01 of the Standard Specifications.

Requirements:

- | | |
|--------------------------|--|
| A. Sanitary Assembly: | Hose: 3” Diameter Flexible Hose
Collar: Steel
2-1/2” Diameter Pipe: Steel
Swivel Elbow: Steel |
| B. Sanitary Hose Hanger: | Post: 3” Diameter steel pipe
Plate: A36 Steel
Coupling: Brass
Adapter: Brass |

- Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- Lugs: Mechanical type, suitable for number, size, and conductor material.
- Enclosure Type: NEMA 3R
- Labeled for use as service equipment

Cleaning Cabinet

The Cleaning Cabinet shall be a self-contained insulated stainless steel cabinet model MSV7 as manufactured by Vogelsang Mischinenbau GmbH & Co (the Vendor).

Cleaning Cabinet shall include the following:

- Prefabricated base
- Storage compartments
- Instantaneous water heater
- Stainless steel sink with hot & cold water supply facilities
- Automatic dosing units for ready mixing cleaning agents & water
- Electric heat trace for frost protection
- Lighting equipment
- Receptacle cluster for convenience outlets
- Soap dispenser
- First aid kit
- Warning lights to indicate equipment malfunction
- Eye shower

Power provisions within the WEY yard per cleaning cabinet: 1 phase, 277V @ 60 Hz, 22 kW (max) and 1 phase, 120V @ 60 Hz, 1.2 kW (max) for receptacles and accessories.

Construction Methods:

General

If the Contractor's work results in any damage, it shall be his responsibility to replace the damaged items or properties to the Engineer's satisfaction. Any costs involved shall be solely by the Contractor.

The Contractor shall remove and dispose of all excess and packaging materials, and restore the work area to its original or final condition.

Service Consoles

Install as shown on plans. Install concrete for pad/foundation and bollards in accordance with Article 6.01 of the Standard Specifications and details on the plans.

Cleanouts are required within 5' of each service console and as necessary per governing code or as directed by the Engineer.

Cleaning Cabinets

Install cabinet, prefabricated base/foundation and connect to site utilities in accordance with manufacturers requirements and details on the plans.

Unless otherwise indicated on the plans or directed by Engineer, all service console sanitary connections shall be 3" diameter and non-potable water connections shall be 1-1/2" diameter. Conversions from Metric to English fittings shall be per manufacturer's recommendations using transition fittings/couplings to join dissimilar piping materials and sizes. Transition fittings/couplings shall be of the appropriate type for the intended purpose (subsurface, pressure or non-pressure).

Service consoles shall be supplied with 15' minimum heat trace for frost protection of the non-potable water connections.

Cleanouts are required within 5' of each cleaning cabinet and as necessary per governing code or as directed by the Engineer.

Non-fusible switches shall be coordinated between the Contractor and the Vendor to provide integral externally operated switches for both the 120V and 277V circuits. Disconnects shall be capable of accepting incoming wire sizes as specified on the contract drawings.

The Contractor shall test the Cleaning Cabinets in accordance with the manufacturer's recommendations prior to acceptance and submit associated test reports for review.

Splices

Resin-filled splice shall be covered with two, half-lapped layers of vinyl tape and two coats of sealer or shrinkable tubing. Splices shall be completed in NEC approved spliced locations.

Field Quality Control

Piping Tests: Conduct sewer piping tests before joints are covered.

Cleaning Cabinets: Final installation shall be inspected by a Vendor factory authorized representative.

Method of Measurement:

Service Console work shall be measured for payment by the actual number of service consoles installed and accepted by the Designer.

Cleaning Cabinet work shall be measured for payment by the actual number of cleaning cabinets installed and accepted by the Designer.

Service Console Piping work shall be measured for payment on a lump sum basis.

Basis of Payment:

Service Consoles: This work shall be paid for at the contract unit price per each “SERVICE CONSOLE” complete in place. This price shall include full compensation for furnishing and installing pipe warning tape, sewer assemblies, concrete pads, bollards, painting, geotextile, crushed stone, subbase, processed aggregate base, above grade pipes, fittings, hydrants, hoses, accessories, and all materials, equipment and labor.

Cleaning Cabinets: This work shall be paid for at the contract unit price per each “CLEANING CABINETS” complete in place. This price shall include full compensation for furnishing and installing cleaning cabinets, prefabricated base/foundations, pipe warning tape, sewer assemblies, bollards, geotextile, crushed stone, subbase, processed aggregate base, Vendor commissioning and inspection, procurement, shop drawings, plumbing, pipes, fittings, valves, fixtures, luminaires, receptacles, electrical switches, electrical components, junction boxes, switches, breakers, grounding conductors, grounding rods, accessories, all materials, labor and other incidental work required to support the features listed above.

Service Console Piping: This work shall be paid for at the lump sum price for “SERVICE CONSOLE PIPING” complete in place. This price shall include piping, excavation, pipe warning tape, curb stops, services boxes, fittings, testing, cleaning and all material, equipment and labor.

Non-potable water service connections shall be paid for under item “SERVICE CONNECTION (WATER)”.

<u>Pay Item</u>	<u>Pay Unit</u>
Service Console	EA
Cleaning Cabinet	EA
Service Console Piping	LS

- ITEM #1301080A – 4” DUCTILE IRON PIPE (WATER MAIN)**
- ITEM #1301082A – 8” DUCTILE IRON PIPE (WATER MAIN)**
- ITEM #1301084A – 12” DUCTILE IRON PIPE (WATER MAIN)**
- ITEM #1302002A – 4” GATE VALVE**
- ITEM #1302004A – 8” GATE VALVE**
- ITEM #1302120A - 4” INSERTION VALVE (WATER MAIN)**
- ITEM #1302122A - 8” INSERTION VALVE (WATER MAIN)**
- ITEM #1302124A - 12” INSERTION VALVE (WATER MAIN)**
- ITEM #1302203A - 4”X4” TAPPING SLEEVE+VALVE**
- ITEM #1302206A - 8”X8” TAPPING SLEEVE+VALVE**
- ITEM #1302207A - 8”X4” TAPPING SLEEVE+VALVE**
- ITEM #1302217A - 12”X12” TAPPING SLEEVE+VALVE**
- ITEM #1303204A – HYDRANT ASSEMBLY (WATER MAIN)**
- ITEM #1304083A – POLYETHYLENE ENCASEMENT OF PIPE (WATER MAIN)**

Description:

The work specified under these items includes the installation of new ductile iron water main for both domestic and fire protection purposes, at locations and to the lines, grades, dimensions, and details shown on the drawings, complete as shown, specified and directed.

Scope:

- A. Ductile iron pipe items include furnishing and installation of water main pipe and appurtenances including but not limited to: installation of associated fittings and appurtenances, connection to existing utilities, installation of joint restraints, thrust blocks, tie downs, tee-fittings, air vent/chlorination assemblies, blow-off assemblies, testing of mains, disinfection of mains and all other incidental work required to construct the water mains, except as otherwise herein provided for.
- B. Ductile iron gate valve items include furnishing and installation of gate valve assemblies. The work shall include the fabrication and installation of the complete assemblies including gate valve, valve boxes and covers, joint restraint, anchors, concrete blocking and all other incidental work, except as otherwise herein provided for.
- C. Hydrant assembly item includes furnishing and installation of hydrant assemblies. The work includes fabrication and installation of the complete assemblies including hydrant, hydrant shoe, pipe, associated fittings and appurtenances, joint restraints, thrust blocks,

tie downs, valves, valve boxes, concrete collars, felt wrapping, and all other incidental work, except as otherwise herein provided for.

- D. Polyethylene encasement of pipe includes furnishing and installation of polyethylene encasement around all proposed ductile iron water main pipe, associated connections, fittings, gate valves, tapping sleeves, and any other locations where new or disturbed ductile iron is in direct contact with the earth.

Quality Assurance:

- A. Provide one person who shall be present at all times during execution of the work, who is thoroughly familiar with the types of materials used and execution of the work, and who shall direct all work under this section.
- B. Use all means necessary to protect materials and appurtenances before, during, and after installation including proper storage. Follow the manufacturers' recommended procedures for unloading, storage and installation where applicable.
- C. In the event of damage or theft, make all repairs and replacements necessary, subject to approval by the Engineer, at no additional cost to the Department.
- D. Provide the necessary equipment or secure a testing firm to conduct pressure, leakage, disinfection, infiltration, deflection, and lamping tests on the installed utilities, and, if required, concrete testing and loaded truck test.
- E. Comply with all applicable standards referenced below and all conditions required by State or local permits.

Submittals:

- A. Provide product data for each type of pipe, fittings, assemblies, joint restraints, polyethylene encasement, accessory and components specified. Include the Manufacturer's descriptive literature, catalog data and other pertinent information sufficient to clearly demonstrate compliance with the contract documents
- B. Submit written results of all tests performed on the installed utilities and appurtenances for approval.
- C. The Contractor shall field verify water main profiles and crossings and submit as-built drawings at completion of the work.

Materials:

A. Piping:

1. Ductile iron pipe shall conform to the requirements of AWWA C-151. The pipe shall be Class 52 with a rated working pressure of 350 psi. Rubber gasket push-on joints conforming to AWWA C-111 shall be used. The pipe shall be cement-mortar lined in accordance with AWWA C-104. Ductile iron pipe bell restraint shall meet or exceed ANSI/AWWA C151A21.51 and ANSI/AWWA C150/A21.50 standards and shall consist of a wedge action restraint ring on the spigot joined to a split ductile iron ring behind the bell. The product shall be the Series 1700 MEGALUG restraint harness, manufactured by EBAA Iron, Inc. or approved equal. The restraint devices shall be coated using MEGA-BOND by EBAA Iron, Inc. or approved equal.
2. All joints shall be fully restrained as shown on the drawings.

B. Valves:

1. Valves shall conform to the requirements of AWWA C-515 and be of equal quality to Mueller A2360.
2. Valves shall have ductile iron bodies, inside screws, resilient seats and non-rising stems.
3. Valves shall open clockwise.
4. All nuts and bolts shall be stainless steel.

C. Fittings:

1. Fittings shall be ductile iron conforming to AWWA C-110 and have mechanical joints unless otherwise noted.
2. Restraint devices for mechanical joint fittings and appurtenances shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. The product shall be the Series 1100 MEGALUG restraint harness, manufactured by EBAA Iron, Inc. or approved equal. The restraint devices shall be coated using MEGA-BOND by EBAA Iron, Inc. or approved equal.
3. All fittings shall be fully restrained as shown on the drawings.

D. Tapping sleeve and valve:

1. The tapping sleeve shall be stainless steel with a connecting flange conforming to AWWA C115 and be of equal quality to Power Seal 3490MJ. All nuts and bolts used with the steel sleeve shall be AISI Type 304 stainless steel. An integral test plug shall be provided with the sleeve.
2. Valves shall meet the requirements indicated in section B.
3. An air vent/chlorination assembly with corporation stop (Mueller 15000 or equal) shall be installed in the first length of pipe for disinfection or as directed by the Engineer.

E. Insertion Valves:

1. The insertion valves shall have a stainless steel body, bonnet and a reinforced composite polymer valve cartridge to provide superior corrosion resistance, strength and a pressure rating that meets or exceeds the requirements of resilient seated gate valves. The insertion valve shall be stainless steel construction for corrosion resistance, maximum toughness and strength. Insertion valves must be capable of working on Cast/Grey Iron or Ductile Iron Class A, B, C and D, IPS PVC, C900 and C909 PVC, Steel and AC pipe diameters without changing either top or bottom portion of split valve body or using a transition gasket.
2. Insertion valves shall be rated for 250 psi maximum working pressure and the pressure rating must be permanently marked into the body.
3. Valves shall meet the general requirements indicated in section B
4. The wedge gate shall be inert & impervious to corrosion. It shall be symmetrical and seal equally well with flow in either direction.

F. Valve Boxes:

1. Valve boxes shall be cast iron and be the extension, two piece sliding type of equal quality to Mueller H-10364. Cover shall read WATER or as otherwise noted. Valve boxes shall be provided with gate box aligners and mud caps.

G. Polyethylene encasement:

1. Polyethylene encasement shall be furnished and installed in accordance with AWWA C-105 latest revision to all piping, castings, fittings, valves, and couplings for the entire length of direct-buried ductile iron pipe to be supplied on the project.

2. The polyethylene encasement shall prevent contact between the pipe and the surrounding backfill and bedding material, but it is not intended to be completely airtight or watertight.
3. Contractor shall supply eight-mil minimum thickness polyethylene tube manufactured in accordance with AWWA C-105 latest revision for encasement of ductile iron waterline.
4. Linear low-density polyethylene film shall be manufactured of virgin polyethylene material in accordance with ASTM D4976. Physical properties of finished film:
 - Tensile strength 3,600 psi *
 - Elongation 800 percent *
 - Dielectric strength 800 V/mil thickness minimum
 - Impact Resistance 600 g minimum
 - Propagation Tear Resistance 2,550 grams force minimum *
 - *Minimum in machine and transverse direction
5. Polyethylene tube to be supplied shall be black (weather resistant) in color. Tube width sizes shall be per AWWA C105 as shown on the following chart:

<u>Nominal Pipe Diameter</u>	<u>Min. Polyethylene Width for Flat Tube</u>
4"	14"
6"	16"
8"	20"
10"	24"
12"	27"

6. The polyethylene film supplied shall be clearly marked every two feet along its length with the following information in one-inch high letters:

Manufacturer's name or trademark
 Year of Manufacture
 ANSI/AWWA C105/A21.5
 Minimum film thickness and material type
 Applicable range of nominal pipe diameter size(s)
 Warning – Corrosion Protection – Repair any damage.
 Polyethylene adhesive tape 1-1/2-inch wide shall be used to seal joints.

H. Warning/Identification Tape with Tracer Wire:

1. Detectable Warning Tape: Warning tape shall meet the requirement set forth in Form 817 Article 1.20-1.05.15 – Facilities Construction – Markings for Underground Facilities and comply with APWA color code requirements.

0300-0138 ITEM #1301080A, #1301082A, #1301084A, #1302002A, #1302004A, #1302120A, #1302122A, #1302124A, #1302203A, #1302206A, #1302207A, #1302217A, #1303204A, #1304083A

2. The warning tape shall be acid and alkali-resistant with a minimum tape thickness of 5.0 mils. Tape shall have a minimum strength of 5,800 psi, and a maximum 80 percent elongation.
3. Tracer wire shall be #14 AWG solid copper UF type wire with cross-linked polyethylene insulation. The insulation shall be white or yellow in color.
4. Wire splices (at pipe tees, crosses and laterals) shall be accomplished using a direct bury silicone-filled capsule tube with standard wire nut or silicone-filled wire nut connectors of the appropriate size.

I. Hydrant Assembly

1. Hydrant assemblies shall be as indicated on the drawings.
2. Hydrants shall be dry barrel type conforming to AWWA C-502 and be equal quality to Metropolitan 250 - Model 94 as indicated on the drawings. Hydrants shall have national standard threads. Main valve opening shall be 5-1/4 inches and open counter clockwise.
3. Piping for hydrant assembly shall be 6-inches diameter ductile iron, class 52 as indicated in section A. The minimum horizontal distance between the hydrant and gate valve shall be 6-1/2 feet.
4. Fittings for hydrant assembly shall be as indicated in section C.
5. Gate valve for hydrant assembly shall be 6-inches and as indicated in section B.
6. Valve box for hydrant assembly shall be as indicated in section F.
7. Thrust blocks and concrete associated with the hydrant assembly shall be class "C" concrete and conform to Section M.03.
8. Asphalt impregnated felt wrapping for concrete collar shall be saturated felt in a uniform, flexible felt of organic fibers, impregnated with an asphalt saturant.

J. Thrust blocks

1. Concrete thrust blocks are required at all 90 bends, tees and dead-ends, excluding 90 degree bends up to fire hydrants, and shall be class "C" concrete with no reinforcing and configured as shown on the drawings.

K. Waterstops

1. Waterstops shall be class "C" concrete with no reinforcing at locations shown on the drawings.

L. Pipe Bedding

1. Pipe bedding shall be gradation No. 6 crushed stone at depths as indicated on the drawings and gradation conforming to M.01.02.

M. Backfill

1. Backfill material shall be in accordance with applicable parts of the contract documents and as approved by the Engineer.

N. Geotextile

1. Geotextile shall be in accordance with Article 7.55.

Construction Methods:

A. Confirmation of Existing Conditions:

1. The Contractor shall perform additional underground exploratory investigations as indicated on the Plans (i.e., test pits) or as directed the Engineer to determine a clear path/space for all new water main items. Verify the location and depth of the existing mains where applicable or as directed by the Engineer. Revisions are to be made to the relevant plans by the Contractor based on the underground exploratory investigations. These alterations are to be submitted to the Engineer, along with the accompanying profile and detail drawings, for approval prior to proceeding with the work in the field.

B. Handling Material:

1. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipes or coatings. Pipes or fittings shall not be dropped.
2. Pipes and fittings shall be subjected to a careful inspection before installation. All defective pipes and fittings shall be removed from the site at no cost to the Owner. If any portion of a pipe is cracked or defective the entire length shall be removed.

C. General:

1. Shape trench bottoms to give uniform circumferential support to the full length of each section of pipe.
2. Geotextile shall be furnished and installed as called for in the contract drawings.
3. Water pipe shall be installed with a minimum of 4 ½ feet of cover below finish grade. The Contractor shall notify the Engineer immediately if there are areas where underground obstructions are encountered that prevent achieving at least minimum cover for water piping installations. The Contractor shall not install water piping with less than minimum cover unless specifically directed to do so by the Engineer in writing.
4. Place bedding material below the bottom of the pipe. Smooth the bottom of the trench to provide continuous support under the pipe. Carefully lower the pipe into the trench, avoiding disturbance of the bed and trench walls, and damage to the pipe. Lay the pipe with the bells on the upgrade end.
5. Clean the coupling ring groove and install the rubber gasket. Lubricate the gasket with the lubricant supplied by the manufacturer of the pipe. Taking care to avoid the entrance of foreign material, join the sections. Check joints to insure proper seal.
6. Remove all lumps, blisters and excess coating from the bell. Wire brush the inside of the bell and wipe clean.
7. Where a gland is used at a valve or fitting, the gland and rubber gasket will then be placed on the spigot end of the pipe. The pipe will then be pushed forward to seal the spigot end in the bell and the gasket pressed into place within the bell. The gland will then be moved into place and bolted. Torque the bolts per Manufacturer requirements.
8. After installation of the pipe to the proper line and grade, place granular around the pipe to the top of the pipe, carefully tamping under the haunches. Backfill shall be compacted as required by respective material item.
9. Push-on joints shall be made up by first inserting the gasket into the groove of the bell and applying a thin film of non-toxic gasket lubricant uniformly over the inner surface. The chamfered end of the plain pipe shall be inserted into the gasket and forced past it until it seats against the bottom of the socket.
10. When cutting pipe is required, the cutting shall be done by machine leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.

11. Whenever encountered within the trench, existing utilities, including those not shown on the plans, shall be supported.
12. Ductile iron pipe and fittings shall be installed in accordance with the requirements of AWWA Standard Specification C600, except as otherwise noted herein. A firm, even bearing throughout the length of the pipe shall be constructed by tamping selected material at the sides of the pipe up to the springline. Blocking will not be permitted.
13. When construction is not in progress, including lunchtime; the open ends of the pipe shall be closed by watertight plug or other approved means. The Contractor shall keep the trench free from water while the pipe is being installed.
14. Fittings, in addition to those shown on the plans, shall be provided, if required, for crossing utilities, which may be encountered.
15. Installation of short pieces on either side of a fitting will not be permitted.
16. Contractor shall restrain all joints using “Mega-lugs” or approved equal. In addition, the Contractor shall place concrete thrust blocks at all 90 bends, tees, and dead-ends as indicated in the drawings. Where thrust bocks are required, install polyethylene encasement prior to placing concrete. Do not backfill until the concrete has cured 24 hours.
17. Do not interrupt existing services without prior approval from the Engineer. Schedule interruptions in advance and submit, request for interruption with methods proposed to minimize length of interruption, in writing. Interruptions shall be scheduled at such times of day and work to minimize impact on rail operations. Provide 72 hours minimum notice to CTDOT Rail Operations and Metro North Railroad prior to any interruption to service to rail yard facilities.

D. Separation of Potable Water Mains and Sewer Lines

1. Parallel Installation: Water mains shall be laid at least 10 feet horizontally from any existing or proposed sewer or non-potable line. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten-foot separation, it is permissible to install a water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.
2. Crossings: Water mains crossing sewers shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. The water main shall cross over the sewer. At crossings,

one full length of water pipe shall be located so both joints will be as far from the sewer as possible.

3. When it is impossible to obtain the horizontal and vertical separation specified, construct both the water main and the sewer or non-potable line with restrained joint cement lined ductile iron pipe.

E. Testing Water Mains

1. After the pipe has been laid and 7 days after the concrete thrust blocks and anchors have been placed, the water main shall be hydrostatically tested according to AWWA C600.
2. Contractor shall supply all necessary apparatus to perform the hydrostatic test.
3. Test pressure shall be 200 pounds per square inch or 1.5 times the working pressure at or near the high point in the system, whichever is greater. Test shall be a minimum of two (2) hours in duration and the test pressure shall not vary more than five (5) psi for the duration of the test.
4. Allowable leakage shall be computed by the formula: $Q = S * D * (P)^{1/2} / 133,200$ where Q is leakage in gallons per hour, S is the length of pipe tested in feet, D is the nominal diameter of the pipe in inches, and P is the average test pressure in pounds per square inch (gauge) during the test (AWWA C600).
5. Replace and re-test any work found to be defective.

F. Testing Hydrants

1. After testing the water mains, open the hydrant fully and fill with water. To prevent caps from being blown off, vent air from one of the caps while it is being filled. When all the air has escaped, tighten the cap.
2. Allow the pressure to build up to main line pressure and check for leakage at flanges, nozzles and the operating stem.
3. Close the hydrant, remove one nozzle cap and place the palm of your hand over the opening. Drainage should create a noticeable suction.

G. Disinfection:

1. Prior to being put into service, water mains shall be disinfected in accordance with AWWA Specification C-651.
2. The interior of the pipe shall be flushed and then disinfected in all parts. Water supply control (gate) valves installed shall be in the full open position during

0300-0138 ITEM #1301080A, #1301082A, #1301084A, #1302002A, #1302004A, #1302120A, #1302122A, #1302124A, #1302203A, #1302206A, #1302207A, #1302217A, #1303204A, #1304083A

flushing procedures. Water mains shall be flushed for a minimum of five (5) minutes after water flows clear and free of visible obstructions. The disinfection shall result in eliminating from the new pipe line all evidence of contamination, as determined by tests of the bacterial content of samples of water taken from the new water main.

3. Chlorination shall be accomplished by introducing a hypochlorite solution with a concentration of 50 parts per million of available chlorine into all the various parts of the new water mains. Maintain the heavily chlorinated water in the main for 24 hours during which time all main line valves should be operated. After 24 hours, the minimum chlorine residual must be at least 10 parts per million.
 4. Flush heavily chlorinated water from the line and refill the line for service. Take and submit two bacteriological samples of the water to the State of Connecticut Department of Public Health, State-approved testing laboratory, or Facility as ordered by the Engineer. If the results are unsatisfactory, the disinfection procedure will be repeated until satisfactory results are obtained.
 5. The Contractor shall furnish and install suitable interim testing plugs, caps, pumps, pipe connections and other appurtenances as necessary and all labor required for testing bacteria and disinfecting the water mains.
 6. Any temporary equipment or materials needed to flush underground mains shall be provided during construction and capable of handling the required water flows.
 7. The Contractor shall dispose of the test water to the sanitary sewer system.
 8. Provide one week notice to the Engineer prior to performing disinfection
- H. Underground Utility Marking: refer to Section 1.20-1.05.15.
- I. Waterstops: Place concrete waterstop full width of trench from bottom of trench to 12” above pipe every 100’ or as directed by the Engineer. A minimum width of 6” is required for each waterstop.
- J. Valves, Couplings, and Fittings:
1. Check operation of all valves before installing.
 2. Install per accepted manufacturer's written instructions and the requirements of AWWA C500. All bolt threads shall be lubricated with graphite and oil prior to installation.
 3. Install support blocking as shown on the plans.

4. Valve box covers shall be seated flush with the surface of the proposed ground or paved surface. Covers located in areas surfaced or to be surfaced with asphalt or concrete shall be set in a 24-inch diameter x 6-inch thick concrete ring. The concrete ring shall be omitted in other locations.
 5. Valves shall be tested prior to installation. Approval by Engineer must be obtained prior to backfilling.
 6. Anchors and concrete blocking, as required, shall be constructed in locations as directed by the Engineer.
 7. Install tapping sleeve and tapping valve per manufacturer's requirements.
 8. Insertion valves shall be installed per manufacturer recommendations and at locations as indicated on the plans, unless otherwise directed by Engineer.
- K. The hydrant connecting pipe shall be the same depth as the distribution main and have a concrete collar 1'-8" x 3' x 1' constructed 6 inches below finished grade. The hydrant shall be set in a 3' x 2' x 2' drain pocket of ¾" crushed stone and set on a hydrant "shoe" manufactured specifically for that purpose. Thrust blocking may be required depending on soil type. The hydrant and valve box shall be set plumb. The pumper nozzle shall face the street.
- L. Excavation and Backfill shall be performed in accordance with the contract documents and approved by the Engineer.
- M. Polyethylene Encasement
1. All proposed ductile iron pipe water mains and fire mains of any size and associated connections, fittings, gate valves, tapping sleeves, etc. are to be encased in polyethylene as specified below.
 2. The Contractor shall remove all lumps of clay, mud, cinders, etc. on the pipe surface before installation of the polyethylene encasement. During installation, soil or embedment material shall not be trapped between the pipe and the polyethylene.
 3. Sufficient slack shall be provided in contouring to prevent stretching the polyethylene where it bridges irregular surfaces, such as bell-spigot interfaces, bolted joints, or fittings and to prevent damage to the polyethylene caused by backfilling operations. Overlaps shall be secured with adhesive tape.
 4. For installation below the water table circumferential wraps of tape shall be placed at 2 feet intervals along the barrel of the pipe to minimize the space between the polyethylene and the pipe.

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5. Installation on ductile iron pipes shall be in accordance with methods A or B as specified in AWWA-C105 and below:
 - a. Method A: Cut polyethylene tube to a length approximately 2-feet longer than the pipe section. Slip the tube around the pipe, centering it to provide a one-foot overlay on each adjacent pipe section and bunching it accordion-fashion lengthwise until it clears the pipe ends. Lower the pipe into the trench and make up the pipe joint with the preceding section of pipe. A shallow bell hole must be made at the joints to facilitate installation of the polyethylene tube. After assembling the pipe joint, make the overlap of the polyethylene tube. Pull the bunched polyethylene from the preceding length of pipe, slip it over the length of the new length of pipe, and secure it in place. Then slip the end of the polyethylene from the new pipe section over the end of the first wrap until it overlaps the joint at the end of the preceding length of pipe. Secure the overlap in place. Take up the slack along the barrel of the pipe, securing the fold at quarter points. Proceed to the next section of pipe in the same manner.
 - b. Method B: Cut polyethylene tube to a length approximately one foot shorter than that of the pipe section. Slip the tube around the pipe, centering it to provide 6-inches of bare pipe at each end. Take up the slack width at the top to the pipe for a snug but not tight fit along the barrel of the pipe securing the fold at quarter points. Secure the ends with polyethylene tape.
6. Before making up a joint, slip a three-foot length of polyethylene tube over the end of the preceding pipe section, bunching it accordion-fashion lengthwise. Alternatively, place a three-foot length of polyethylene sheet in the trench under the joint to be made. After completing the joint, pull the three-foot length of polyethylene over or around the joint, overlapping the polyethylene previously installed on each adjacent section of pipe by at least one-foot. Snug each end and secure with polyethylene tape. A shallow bell hole is necessary and shall be made at joints to facilitate the installation of the polyethylene tube or sheet.
7. Care shall be taken when backfilling to prevent damage to the wrapping.
8. Repairs: repair cuts, tears, punctures, or damage to polyethylene with adhesive tape or with a short length of polyethylene sheet, or with a tube cut open, wrapped around the pipe to cover the damaged area, and secure in place.
9. Openings in encasement: provide openings for branches, service taps, blow-offs, air valves, and similar appurtenances by cutting an "X" in the polyethylene and temporarily folding back the film. After the appurtenance is installed, tape the slack securely to the appurtenance, and repair the cut and any other damaged

areas in the polyethylene, with any resulting damaged areas being repaired as described previously.

10. To make direct service taps, apply two or three wraps of adhesive tape completely around the polyethylene encased pipe to cover the area where the tapping machine and chain will be mounted. After the tapping machine is mounted, the corporation stop is installed directly through the tape and polyethylene. After the direct tap is completed, the entire circumferential area shall be closely inspected for damage and repaired if needed.
11. Junctions between wrapped and unwrapped pipe: Where polyethylene wrapped pipe joins an adjacent pipe that is not wrapped, extend the polyethylene wrap to cover the adjacent pipe for a distance of at least three feet. Secure the end with circumferential turns of adhesive tape.

Method of Measurement:

- A. Ductile iron water pipe will be measured for payment per linear foot completed and accepted in place, which price shall include all associated couplings, fittings, appurtenances, joint restraints, thrust blocks, tie downs, air vent/chlorination assemblies, blow-off assemblies, connections to existing utilities, testing and disinfection.
- B. Ductile iron gate valves will be measured for payment by the actual number of gate valves installed and approved by the Engineer. Price shall include gate valve, valve boxes and covers, joint restraints, anchors, concrete blocking and all other incidental work required to complete the valve assembly.
- C. Hydrant assemblies will be measured for payment by the actual number of hydrant assemblies, installed and approved by the Engineer. The assembly includes hydrant, hydrant shoe, pipe, associated fittings and appurtenances, joint restraints, thrust blocks, tie downs, valves, valve boxes, concrete collars, felt wrapping, and all other incidental work required to complete the hydrant assembly.
- D. Insertion valves will be measured for payment by the actual number of valves installed and approved by the Engineer. Price shall include insertion valve, valve boxes and covers, joint restraints, specialty tools and all other incidental work required to complete the valve assembly.
- E. Tapping sleeve and valves will be measured for payment by the actual number of tapping sleeves and valves installed and approved by the Engineer. Price shall include tapping sleeve, gate valve, valve boxes and covers, joint restraints, anchors, concrete blocking and all other incidental work required to complete the valve assembly.

- F. Polyethylene encasement of pipe item will be measured for payment per linear foot completed in place, which price shall include the cost of installing, repairing, sealing, taping, and all associated work.
- G. Excavation, Trench Excavation, Rock-in-Trench Excavation, Geotextile, No. 6 Crushed Stone, Granular Fill and Suitable Backfill Material shall be paid separately under the applicable Items.
- H. Test Pits shall be paid separately under the item "Test Pit (Estimated Cost)".

Basis of Payment:

- A. Ductile iron water pipe will be paid for at the contract unit price per linear foot, complete in place, including all materials, fittings, couplings, assemblies, restraining devices, waterstops, equipment, testing, tools and labor incidental thereto.
- B. Ductile iron water gate valves will be paid for at the contract unit price each for "Gate Valve" (Any Size) as called for on the plans, complete in place, which price shall include the cost of the valve, valve box, anchors, concrete blocking, and all incidental work.
- C. Hydrant assemblies will be paid for at the contact unit price each for "Hydrant Assembly (Water Main)", complete, in place. The price shall include furnishing and installing pipe, valves, valve boxes, hydrant shoes, restraining devices, hydrant, concrete collar, thrust blocks, and all other work incidental to the proper completion of the work.
- D. Insertion valves will be paid for at the contract unit price each for "Insertion Valve" (Any Size) as called for on the plans, complete in place, which price shall include the cost of the valve, valve box, specialty tools, and all incidental work.
- E. Tapping sleeves and valves will be paid for at the contract unit price each for "Tapping Sleeve+Valve" (Any Size) as called for on the plans, complete in place, which price shall include the cost of the valve, valve box, anchors, concrete blocking, and all incidental work.
- F. Polyethylene encasement will be paid for at the contract unit price per linear foot for "Polyethylene Encasement of Pipe (Water Main)" as called for on the plans, complete in place, which price shall include the cost of installing, repairing, sealing, taping, and all associated work.
- G. Trench Excavation, Rock-In-Trench Excavation, Geotextile and Bedding Material shall be paid for separately under the applicable item.

<u>Pay Item</u>	<u>Pay Unit</u>
4" DUCTILE IRON PIPE (WATER MAIN)	LF
8" DUCTILE IRON PIPE (WATER MAIN)	LF
12" DUCTILE IRON PIPE (WATER MAIN)	LF
4" GATE VALVE	EA
8" GATE VALVE	EA
4" INSERTION VALVE (WATER MAIN)	EA
8" INSERTION VALVE (WATER MAIN)	EA
12" INSERTION VALVE (WATER MAIN)	EA
4"X4" TAPPING SLEEVE+VALVE	EA
8"X'8" TAPPING SLEEVE+VALVE	EA
8"X4" TAPPING SLEEVE+VALVE	EA
12"X12" TAPPING SLEEVE+VALVE	EA
HYDRANT ASSEMBLY (WATER MAIN)	EA
POLYETHYLENE ENCASEMENT OF PIPE (WATER MAIN)	LF

ITEM #1403009A – MANHOLE-TYPE 2 (SANITARY SEWER)

Description:

Scope

This item shall consist of furnishing and installing a channel flow sanitary sewer grinder for the discharge from the WEY sanitary sewage collection system. The work shall include the control & alarm system, associated wire from the controller to grinder, manhole, and concrete shelf within the manhole. The manhole is a Class 1, Division 1 location and all fittings, junction boxes, and enclosures shall be rated for use in this environment.

Related Work

Related requirements are included in, but not limited to, the following:

1. 600 Volt Copper Wire Items
2. Duct Bank and Direct Buried Items
3. Manhole Over 10' Deep (Sanitary Sewer)

Submittals

Submit the following in accordance with the Standard Specifications Article 1.20-1.05.02:

The Contractor shall prepare detailed designs for each of the required assemblies based on the information specified on the Contract Documents, including, grinder & enclosures indicating all the components included, including power connection, control & alarm system, mounting details, enclosure operating mechanisms, other related assemblies on the structure, including details and dimensions of the parts and their relationship to each other, and describing the material composing the various parts, together with technical, mechanical and electrical characteristics including but not limited to the following:

1. Sufficient information, clearly presented, shall be included to determine compliance with Plans and Specifications.
2. Include electrical ratings, nameplate data, impedance, dimensions, weight, mounting details, decibel rating, termination information, temperature rise, no load and full load losses, regulation, over current protection, connection diagrams, and accessories.
3. Complete nameplate data including manufacturer's name and catalog number.

Provide manufacturer's installation manual.

Provide grinder parts list.

Provide copies of manufacturer's Operation and Maintenance Data: To include in emergency, operation, and maintenance manuals as specified in NOTICE TO CONTRACTOR CLOSE OUT DOCUMENTS.

Provide copies of manufacturer's guarantee for sanitary grinder.

As-Built drawings shall be submitted prior to the close out of the project.

Training syllabus with training material shall be submitted for approval to MNR. Once approval is obtained, the contractor shall schedule a one day training sessions for MNR staff.

Provide Spare Parts

Provide one spare grinder assembly.

Quality Control

The manufacturer of the sewage grinder pumps and enclosures shall have manufactured grinder pump units for a minimum of five (5) years.

Materials:

Manhole

Manhole structure, frame and cover, steps, waterproofing, aggregate base, grout, and backfill, shall be constructed to the same materials and requirements as item "MANHOLE OVER 10' DEEP (SANITARY SEWER)". Includes the design of the structure approved and signed by a Civil or Structural Engineer in the State of Connecticut meeting the design requirements provided in the referenced item such as Cooper E80 loading applied at 4'-3" from the centerline of track and associated design load requirements.

Bar Grate

- A. The bar grate shall be T304 heavy duty stainless steel grating – size 1" x ¼".

Grinder

- A. Provide an open channel twin-shaft grinder designed for below-ground installation and rated for residential and light commercial service consisting of the following main components:
 1. Grinder assembly (lower works)
 2. Drive assembly
 3. Grinder assembly guide

B. Grinders and motors shall be specifically designed and manufactured to operate in a completely submerged environment in the liquid being pumped.

C. Operating & Performance Criteria:

1. The grinder shall employ counter rotating cutter stacks with intermeshing cutters driven by a common drive.
2. The shafts shall counter-rotate with the driven cutter peripheral linear speed operating at approximately two-thirds (2/3) that of the drive cutter peripheral linear speed.
3. The twin-shaft grinder shall employ a design wherein cutters fill 90% of the cutting chamber. Units with passive style diverter screens or diverter disks shall not be accepted.
4. The Grinder shall be controlled via a reversing motor starter that will normally operate in the forward direction with momentary reversing operation.
5. Normal Cycle: Placing the selector switch in the Hand or (when a remote run signal is received, if in the Auto position), shall energize the Reverse motor starter and the equipment rotates in that direction for two seconds (adjustable) before the reverse starter coil is de-energized.
 - a. After a delay of five seconds (adjustable) to allow the equipment to coast to a stop, the equipment shall run continuously in the Forward direction of rotation.
 - b. It shall continue to run in this direction until the motor starter is de-energized by interrupting the remote-run signal, or by turning the selector switch to the 'Off' position, or if the equipment experiences a jam condition.
6. Auto Clear Cycle: If the phase current reaches an adjustable set point (factory-set), the motor starter shall be de-energized.
 - a. After a delay of five (adjustable) seconds to allow the equipment to coast to a stop, the sequence described above for a normal starting cycle shall be initiated in an attempt to clear the Jam condition.
 - b. This automatic auto-clear cycle shall repeat a total of four times.
 - c. If at any time the equipment runs for more than 30 seconds continuously in the forward direction during the four attempts, the reversal counter shall be reset.
 - d. Alarm Condition: If after four tries, however, the Jam condition still exists, the forward starter coil shall be de-energized. An Alarm Condition lockout circuit shall then be established and remain in the alarm state (even if power is lost) until it is reset.
 - e. The lockout circuit shall disable the automatic cycle.

D. Manufacturer: The pumping equipment shall be supplied as a complete unit, and all items furnished by the manufacturer:

1. Franklin Miller Incorporated
2. JWC Enviromental
3. Or approved equal

E. Grinder Housing

1. The main grinder housing components shall be constructed of Ductile Iron, shall not be subject to wear from the seal, and shall not constitute a seal wear element.

F. Cutters

1. The cutters shall be a monolithic type comprising a plurality of cam shaped cutter elements. The cartridges shall be designed to eliminate individual cutter and spacer disks for improved strength and transmission of power from the shaft. Units using individual cutters and spacers shall not be accepted.
2. No cutter stack re-tightening shall be required with this system for regular maintenance.

G. Shafts

1. The shafts shall minimally 2 inch in diameter
2. Two-shaft design shall consist of two parallel shafts stacked with intermeshing cutters.
3. The shafts shall counter-rotate with the driven cutter peripheral linear speed operating at approximately two-thirds ($2/3$) that of the drive cutter peripheral linear speed.

H. Side Frames

1. Side frames shall have a high flow design with a series of parallel comb tines designed to enhance liquid flow capacity.

I. Bearings and Seals

1. The bearings and seals shall be housed in replaceable cartridges that support and align the bearings and seals. The cartridge housings shall be constructed of hardened AISI 17-4 PH Stainless Steel for superior resistance to corrosive and abrasive contaminants.
2. The cutter shaft's radial and axial loads shall be borne by a sealed oversize deep-groove ball bearing at each end. C_E Units without bearings on both ends shall not be accepted.
3. The bearings shall be protected by a combination of a replaceable and tortuous path device and end face mechanical seals.
4. Face materials shall be tungsten carbide vs. tungsten carbide and shall not require an external flush.
5. The seals shall employ elastomeric members operating as opposing disk springs when compressed and, at the same time, maintain a positive seal face pressure to ensure positive sealing. No metal springs shall be employed.
6. The contact-less labyrinth rings shall be supplied to further protect from coarse and fine granular contaminants.
7. Components subject to wear shall be designed as replaceable elements and shall not be a part of the ductile iron unit main housing.

J. Painting Specifications

1. All steel or iron structural components shall be prepared and painted in accordance with the following procedures:
 - a. The surfaces shall be properly prepared as defined by (SSPC) Steel Structures Paint Council.

- b. The metal surfaces shall be blast cleaned to near-white in preparation for painting to substantially remove mill scale, rust, paint or foreign matter including oil, grease, dirt or oxides.
2. The cleaned surfaces shall be primed the same day as cleaned.
3. The parts shall be minimally painted with 2 coats of Polyamide Epoxy.
 - a. One (1) coat primer
 - b. One (1) Top coat
4. The dry film thickness shall be 3 to 5 mil per coat.
5. Available colors shall be submitted for Engineers selection.
6. All stainless steel parts, if used, shall not be painted.

K. Reducer

1. The speed reducer shall be a grease-filled cycloidal type reducer with "Heavy-Shock" load classification.
2. Helical gear drives shall not be acceptable.
3. The high-speed shaft of the grinder shall be coupled with the reducer via a coupling.
4. The two-piece, three-lobed coupling shall have jaws that intermesh by at least $\frac{3}{4}$ inch.
5. The reducer shall have a rigid input shaft supported by heavy bearings capable of handling thrust and radial loads and shock conditions.

L. Motor

1. The minimum motor shall be: 3 HP (2.2 kW),
2. Power requirements: 208 Volt, 3-phase, 60 Hz.
3. Motor service factor shall be 1.15 with NEMA premium efficiency standards.
4. Motor shall be explosion proof.

M. Grinder Pump Guide

1. The channel frame shall support the unit and provide for convenient unit removal and installation without bolting of grinder to the channel walls or floor.
2. The channel frame shall be constructed of AISI 304 stainless steel.
3. The unit shall slide vertically into a channel frame slot.
4. The grinder pump guide shall be secured to the channel floor/ wall with anchor bolts.

Alarm and Control System

Provide manufacturer's alarm and control system designed to sequence the operation of the equipment and indicate motor overload or stoppage:

- A. Alarm conditions: pump seal failure, or thermal overload.
- B. enclosure mounted, visual rotating red beacon, with electric bell; 208-V ac, with transformer and contacts for remote alarm bell.alarm silence switch.
- C. Control panel with test switch for alarm and light.

D. Control-Interface Features:

1. Remote Alarm Contacts: For remote alarm interface.
2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - a. On-off status of pump.
 - b. Alarm status.

E. UL listed.

F. Stanchion mounted NEMA 4X enclosure with factory installed viewing window to contain the grinder control panel.

G. Signage: below the Control cabinet, provide signage with 3-inch high red lettering indicating "Storage Yard Sanitary Grinder Failure Alarm" on a white background.

H. Motor starter: A reversing starter shall be based on IEC requirements for the motor horsepower, rated 18A minimum. Motor starter shall be a full voltage reversing type. Forward and reverse contactors shall have both mechanical and electric interlocks.

1. A motor protection relay shall be furnished as part of the starting equipment. The motor protector shall be adjustable so that the range selected includes the motor nameplate listed FLA (full load amps) rating and the service factor.
2. Repeated unsuccessful attempts to start the motor or a short circuit shall cause the motor protector to trip.
3. Tripping of the motor protector shall stop the motor and flash the trip light. Resetting the relay shall allow the alarm circuitry to be reset.

I. Operator Controls: A three-position "HAND-OFF/RESET- AUTO" selector switch shall be provided for the Grinder. Its function is as follows:

1. Hand: When in this position, the equipment shall run under the control of the PLC until the switch is placed in Off/Reset.
2. Off/Reset: When in this position, the motor shall be prevented from starting (in both the forward and reverse directions); the remote-start signal shall be disabled; and the established Alarm Condition lockout circuitry reset.
3. Auto: In this position, when a remote Run signal is received, the motor shall cycle under the control of the PLC. The cycle shall be terminated if the run signal is interrupted, or the selector switch is placed in the Off/Reset position or if the equipment experiences an Alarm Condition.

J. PLC: Provide a programmable logic controller with Ethernet port capable of Modbus/TCP communications, USB programming port, and SD slot for uploading and downloading programming without requirement of a PC.

K. Instrumentation shall be provided as required by manufacturer to meet the specified performance criteria to ensure safe and reliable extended operation.

Power Disconnect

A motor power disconnect shall be provided adjacent to the alarm and control system and sized as indicated on the plans.

A. Manufacturer:

1. Eaton/Cutler-Hammer.
2. General Electric.
3. Siemens Energy & Automation, Inc.
4. Or approved equal.

B. Construction:

1. Switch blades and jaws shall be visible and plated copper.
2. Switches shall have a handle that is easily pad-lockable with three 3/8-inch shank locks in the OFF position.
3. Switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the ON position (except for double-throw switches). Defeater mechanism shall be front accessible.
4. Switches shall have deionizing arc chutes.
5. Switch assembly and operating handle shall be an integral part of the enclosure base.
6. Switches rated 30 A to 600 A shall have reinforced fuse clips.
7. Switch blades shall be readily visible in the "ON" and "OFF" position.
8. Switch operating mechanism shall be non-teasable, positive quick-make/quick-break type. Bail type mechanisms are not acceptable.
9. Embossed or engraved ON-OFF indication shall be provided.
10. Double-make, double-break switch blade feature shall be provided.
11. Renewal parts data shall be shown on the inside of the door.

C. Enclosures: All enclosures shall be NEMA 4x:

1. 30 A to 200 A –316 stainless steel.
2. Factory installed ground terminal block.
3. Nameplate shall be front cover mounted, containing a permanent record of switch type, ampere rating, and maximum voltage rating.

Explosion Proof Fittings

Explosion proof fittings and conduit seals shall be installed in accordance with NEC 501.

A. Manufacturer:

1. Thomas and Betts
2. Cooper
3. Calbrite
4. Or approved equal

- B. Construction
 - 1. Type: EYS
 - 2. Material: Rigid Galvanized Steel
 - 3. Provided with manufacturer's UL listed sealing compound.

Explosion Proof Enclosures

All junction boxes and enclosures located within the manhole shall be rated for installation in Class 1, Division locations.

- A. Manufacturer:
 - 1. Cooper
 - 2. Hoffman
 - 3. Thomas and Betts
 - 4. Or approved equal
- B. Construction:
 - 1. NEMA 7 Enclosure
 - 2. UL 1203 Listed
 - 3. Stainless steel

Conductors and Cables

Conductors and cables shall be provided as required on the plans and per the manufacturers requirements. Wires and cables shall meet the same requirements as set forth in respective items in the contract.

Wire Splices

Wire & cable splices (at pipe tees, crosses and laterals) shall be accomplished using a direct bury type, 600V rated, silicone-filled capsule tube with standard wire nut or silicone-filled wire nut connectors of the appropriate size.

Construction Methods:

General

Shall be located as indicated on the Plans.

Excavation, support of excavation, and dewatering shall be in accordance with contract requirements.

Installation of the sanitary sewer grinder shall be in accordance with written instructions provided by the manufacturer. Installation shall be performed by an installer experienced in the installation of similar pump systems.

Manhole

Manhole shall be constructed to the same requirements as item “MANHOLE OVER 10’ DEEP (SANITARY SEWER)”. Concrete shelf may be cast-in-place once the manhole has been installed or precast into the manhole base. Bar grate shall be installed as indicated in the contract drawings. Reinforcing shall be coordinated with the grinder pump guide to ensure rebar is not broken or cut when installed.

Alarm and Control Panel

Install at the location indicated on the plans or as determined in the field by the Designer.

Pipe Connection

Provide sealed connections for 10-inch SDR35 waste line.

Splices

Resin-filled splice shall be covered with two, half-lapped layers of vinyl tape and two coats of sealer or shrinkable tubing. Splices shall be completed in NEC approved spliced locations.

Operation and Maintenance Manuals

The manufacturer shall also provide copies the operation and maintenance manual covering general operating procedures, operation, maintenance, and servicing procedures of the major individual components, and a trouble-shooting guide as required in the NTC provisions.

Manufacturer’s Representative on Site

The Contractor shall provide the services of a technical representative of the equipment manufacturer to supervise the final adjustments of the system, perform such operating tests as will assure the Designer that the equipment is in proper adjustment and satisfactory operating condition.

Factory-authorized service representative shall perform the following startup services:

- Complete installation and startup checks per manufacturer's written instructions.
- Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- Adjust control set points.

The complete sanitary sewer grinder shall be in good working order, and spare parts provided before it is turned over to the Department for acceptance and operation.

Vendor Training

The Contractor shall provide the services of a technical representative of the equipment manufacturer to instruct and train the operating personnel from Metro North Railroad and the Department in the use of the equipment for a minimum of one (1) day.

Method of Measurement:

Sanitary sewer grinder shall be measured on a per “each” basis, completely installed under item “MANHOLE-TYPE 2 (SANITARY SEWER)”. This work includes all materials, motors, grinders, manhole structures, bar grates, electrical components, controls and alarm devices defined herein, disconnects defined herein, electrical junction boxes, grounding conductor, grounding rods, grout, concrete, and reinforcing.

Basis of Payment:

This work will be paid for at the contract unit price per each Manhole-Type 2 (Sanitary Sewer) installed and accepted, in place, including all materials, equipment, testing, tools and labor incidental thereto. Payment shall also include for providing and connecting to the specified power source.

Trench Excavation, Rock-in-Trench Excavation, No. 6 Crushed Stone, and Granular Fill shall be paid separately under the applicable items.

Wiring and conduit shall be paid separately under the respective direct buried conduit, 600V cable, and/or duct bank items.

Pay Item

Pay Unit

Manhole-Type 2 (Sanitary Sewer)

EA