ITEM 670.9909XX25 – MULTIMODE FIBER OPTIC CABLE

1. DESCRIPTION:

1.01 This work shall consist of furnishing, installing and testing fiber optic cables, connectors and accessories.

2. MATERIALS:

2.01 General. Cables shall comply with applicable requirements of EIA Standards EIA-440, -445, -458, -475, and -509 pertaining to optical-fiber cable and system component construction and installation. In addition, obtain written certification from manufacturer of optical distribution equipment for operation of intended use.

2.02 Cables. Factory fabricated without splices, single channel, low loss, glass type, fiber-optic singlemode cables suitable for direct burial, in conduit or self supporting aerial suspension installations with the number of fibers as specified on the drawings and:

A. Optical Requirements

1. Reflective Index Profile - Multimode

2. Attenuation - The nominal attenuation shall be 1.75 dB/km or less at a wavelength of 1300 nm. Fiber attenuation shall be uniform with no discontinuities greater than 0.05 dB.

3. Bandwidth - The fibers shall have a bandwidth of 500 MHz/km or higher at 1300 nm.

B. Mechanical Requirements

1. Cable

• Fibers - The fibers shall have a nominal core diameter of 62.5 microns.

• Core/Clad Concentricity - Core/Clad concentricity shall be within $\leq 3$ microns.

• Primary Coating - Each fiber shall have a primary coating to prevent abrasion of the fiber surface.

• Buffering - The fibers shall be loose tube buffered.

• Tensile Strength - The cable shall be capable of withstanding a pulling tension of 600 lbs. without changing characteristics of the optical fibers.

• Bend Radius - The cable shall be capable of withstanding a minimum bending radius of 10 times its outer diameter during operation and 20 times its outer diameter during installation without changing the characteristics of the optical fibers.

• Cable Configuration - The fiber optic cable shall have a concentric structure. The buffered fibers shall be surrounding the center strength member.

All strength members shall be non-metallic typically Kevlar or Kevlar and epoxy glass, and shall provide the cable with the specified strength.
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A flame retardant polyethylene inner jacket shall be applied over the cable core, followed by a layer of kevlar to provide the 600 lbs. Pulling strength and to limit cable sag to one (1) percent when suspended aerially, and another flame retardent polyethylene outer jacket shall enclose the entire cable.

The cable shall be fully filled with non-hygroscopic water blocking compound to prevent water and moisture penetration.

The Contractor shall also demonstrate crush and abrasion resistance of final cable design and adequacy for conduit installation under full tensile loads and multiple bends.

- Diameter - The outer diameter of the cable shall be as approved by the Engineer.
- Color Coding - Each fiber buffer jacket shall be color coded separately. Within unit tubes or sub-bundles, each fiber shall have a distinctly different color coding.

2.03 FO Connectors. Fiber-optic cable connectors, compatible with the multimode cable and terminal equipment chosen. Connectors shall reliably and repeatably have minimum coupling loses.

3. CONSTRUCTION DETAILS:

3.01 General

A. Install optical fiber cable indicated, in accordance with manufacturer's written instructions, in compliance with applicable requirements of NEC, and in accordance with recognized industry practices.

B. Coordinate optical fiber cable installation work, including electrical raceway and equipment installation work, as necessary to properly interface with other work.

C. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Use pulling means, which will not apply tension on the fibers and which will not damage conductors or raceway. Do not install conductors in raceway until all work which may cause damage has been completed.

D. No splices are allowed unless specifically directed by Contract drawings.

E. Fiber optic cable installation shall be done by a minimum of two cable manufacturer certified individuals. A list of certified employees shall be submitted and no fiber optic cable installation shall be conducted without at least two people on that list being present at all times.

F. Fiber optic connectorization, splicing, preparation and testing shall be done by a "hands on" certified individual in each of the respective areas. A list of such individuals shall be submitted to the Owner’s Representative and only those people on this list shall be allowed to perform the above mentioned tasks.

G. All fiber connectors and splices shall be in approved enclosures.
Experience Requirements

A. Personnel involved in the installation, splicing and testing of the fiber optic cable shall meet the following requirements:

1. Three (3) years experience in the installation of fiber optic cables, including splicing, terminating and testing singlemode fibers.

2. Two (2) installed systems where fiber optic cables are installed in outdoor conduits and the systems are in continuous satisfactory operation for at least two (2) years. The Conductor shall submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the fiber optic system.

   One (1) fiber optic cable system (which may be one of the two in the preceding paragraph) which the Contractor can arrange for demonstration to Thruway representatives and the Engineer.

3. Splicers shall have been trained and experienced on the specific splicing equipment to be used. Proof of this training must be supplied to the Engineer upon request.

Cable Installation

A. Cables shall be pulled in conduit and trays with a steady pull without jerking. The cable pull shall be stopped and sources of hang-up found and corrected prior to continuing pulling cables. Maximum pulling force shall not exceed 600 lbs. tension or the manufacturer’s recommendation, whichever is less.

B. Cables shall be run as straight as possible with smooth bends; sharp bends, exceeding manufacturers recommended minimum bend radius and kinking of the cables are prohibited.

C. Any cables which have been kinked or bent beyond minimum bending radius shall be replaced at Contractor's expense.

D. Open ends of cables shall be capped to prevent moisture from entering the cables during construction.

E. All interior cable runs shall be contained in conduit or cable tray unless otherwise specified on the Drawings.

F. No more than 270° composed of a maximum of three (3) 90° bends or per manufacturer’s recommendation shall be allowed in any one cable pull.

G. The cable’s maximum tensile rating shall not be exceeded during pull. Rating shall be as specified in “A” above by manufacturer’s date sheet.

H. Any non-hand pulls shall be monitored using a tension scale. Machine pull set ups shall be submitted for approval on a case basis.

I. All cable pulls shall use split mesh grips and a swivel. If multiple cables are being pulled at once ensure tensile load is applied equally to all cables.
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J. Fiber optic cables' outer sheath shall be stripped using cable's ripcord or factory approved adjustable diameter sheath (ring) stripper, hook blade knife and sheath ripper.

K. Stressed pulling ends of fiber cables shall be removed prior to connectorization.

L. All aerial cable runs shall be lashed to a messenger cable or other conduit in accordance with manufacturer's recommendation.

3.04 Installation of Connectors, Accessories

A. Fiber optic connectors, splices, pigtail modules, etc., shall be installed by qualified personnel in strict accordance to the manufacturer’s recommended methods using recommended tools: cleaver, wipes, polisher, sandpapers, crimper, strippers, scissors, epoxy, cleaner, polishing pad and plate, curing oven, inspection microscope etc. If proper equipment is not available work shall not be allowed to continue. If improper equipment is found to have been used or used improperly, the NYSTA may require all work affected to be removed and/or redone at Contractor’s expense.

B. Work surfaces shall be sterilized with alcohol and dried with canned air prior to work.

C. The Contractor shall collect broken or cleaved fiber on the back side of black electrical tape immediately after breakage or cleavage.

D. Connectors shall be cleaned and polished if necessary before connection to hardware. Cleaning shall consist of a minimum of isopropyl alcohol and lens grade tissues.

E. Cleaving shall be done using a universal cleaver that can consistently deliver a high quality (less than 1.2º angle typical) cleaves in the field on multimode fiber.

F. The NYSTA shall be allowed to inspect finished connectors using installers microscope upon timely requests.

3.05 Splicing Requirements

A. All optical fibers shall be spliced to provide continuous runs. Splices shall be allowed only in equipment cabinets or in pull boxes (only as allowed by the Engineer).

B. All splices shall use the fusion technique. Fusion splicing equipment shall be provided by the Contractor and shall be cleaned, calibrated and specifically adjusted to the fiber and environmental conditions at the start of each shift. Splice enclosures, tools and procedures, shall be approved by the cable manufacturer as being compatible with the cable type being delivered.

C. Each spliced fiber shall be packaged in a protective sleeving or housing. Bare fibers shall be completely re-coated with a protective RTV, gel or similar substance, prior to application of the sleeve or housing, so as to protect the fiber from scoring, dirt or microbending.

D. Rack mounted organizer trays shall be used to hold the spliced fibers, with each fiber neatly secured to the tray.

E. Splice loss shall not exceed a mean of 0.05 dB, with 0.02 dB more the norm. This means that 84% of the splices shall be measured to have a loss less than 0.05 dB. If a splice is measured to exceed 0.05 dB during the splicing process it shall be remade, to a maximum of three (3) attempts, or until its loss falls below 0.05 dB. Each attempt shall be recorded for purposes of acceptance.
F. All splice losses shall be recorded in tabular form and submitted to the Engineer for approval. An optical time domain reflectometer (OTDR) shall be used to record splice loss, chart recordings of the “signature” shall be submitted with the splice data with a record of all OTDR settings and the OTDR locations written on the trace.

3.06 **Field Quality Control**

A. General

1. The NYSTA reserves the right to inspect wiring centers, connections, splices, etc., to ensure the Contractor is complying to standards.

2. Personnel performing tests on fiber optic cables shall be "hands on" course certified in using an OTDR on connectorized and unconnectorized fiber optic cables. Only personnel on the Fiber Certified Employee List submitted to the Owner's Representative may conduct tests.

3. All tests shall be witnessed by NYSTA.

4. The Contractor shall notify NYSTA in writing ten (10) working days prior to testing date.

B. Testing of Fiber Optic Cables

1. Factory Testing: The Contractor shall submit four (4) copies of the factory OTDR test results of each cable provided. The manufacturer’s test results shall indicate fiber's total dB loss and its total length. The Contractor shall not accept fibers with factory test results that exceed manufacturer's published maximum loss.

2. Pre-installation Testing: The Contractor shall test the cable while on the spool the day it arrives at the site. The cables shall be tested using an Optical Time Domain Reflectometer (OTDR) with no internal memory, designed for multimode fiber at transmissions wavelength of 1300 nm. The OTDR shall be portable, menu drive, rapid display updating, and have a built-in printer, parameter storage, real time analog output and display distance (M/FC), and absolute attenuation (dB/m, dB/F). The fibers shall be tested using an index matching gel filled lab splice or an XYZ alignment mechanism made specifically for coupling of bare fibers. The unit shall be used in strict accordance with the OTDR manufacturer's recommended test procedures.

   The Contractor shall record and submit test results as follows:

   - The strip chart (x-y) printout of OTDR tests shall have the cable number being tested, all OTDR settings, attenuation (dB), cable length, and the operator's signature. The Contractor shall submit tests results on 8.5” x 11” paper for approval.

3. Post Installation Testing: The total fiber run (connectors, splices and fiber) shall be tested once the system is completely connected to interconnect centers. The test shall use an OTDR (same as specified in above) and the results shall be recorded and submitted as specified above. The fiber run shall be tested at 1300 nm wavelength and in strict accordance with the manufacturer's recommended test procedures.

4. Connectors shall be cleaned prior to reconnection, if disconnected for any reason.
5. Total fiber run loss shall not exceed the value obtained using the following equation:

\[
\text{accepted loss} \leq (\# \text{ of connectors })L_c + (\# \text{ of splices}) L_s + (\# \text{ of feet of cable})L_d
\]

Where:

- \(L_c\) = Maximum connector loss published by Manufacturer (dB)
- \(L_s\) = Maximum splice loss published by Manufacturer (dB)
- \(L_d\) = Maximum fiber loss published by Manufacturer (dB/km)

If the fiber run loss is greater than this value, the Contractor shall provide labor, materials, and equipment required to identify and correct the problem. Solution shall be presented to the Owner's Representative in writing for approval prior to taking corrective action. Contractor shall pay all costs associated with approval corrective action.

3.07 **Documentation Requirements.** Ten (10) complete sets of operation and maintenance manuals shall be provided. The manuals shall, as a minimum, include the following:

A. Complete and accurate as-built schematic diagrams showing the fiber optic cable plant.

B. Complete performance data of the cable plant showing the losses at each splice joint and each terminal connector.

C. Installation, splicing, terminating and testing procedures.

D. Complete parts list including names of vendors.

E. Complete maintenance and trouble-shooting procedures.

F. One (1) month prior to installation, ten (10) copies of the Contractors Installation Practices shall be submitted for approval. This shall include practices, list of installation equipment, and splicing and test equipment. Field quality control procedures shall be detailed as well as procedures for corrective action.

3.08 **Cable Identification.** Fiber optic cables shall be labeled with cable markers specified herein at locations specified below:

A. Fiber optic cables installed aerially, exposed, or in tray shall be labeled every 15 feet.

B. Each individual subcable fiber shall be labeled one inch from connector. (Use label as specified herein.)

C. At pull boxes.

4. **METHOD OF MEASUREMENT:**

4.01 The work will be measured for payment as the number of feet of multimode fiber optic cable satisfactorily installed.
5. **BASIS OF PAYMENT:**

5.01 The unit price bid per foot shall include the cost of all labor, materials and equipment necessary for a complete fiber optic link.

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