Special Specification 6242
Special Fiber Optic Cable

1. DESCRIPTION

The contractor to install, splice, field terminate, test and document all fiber systems.

2. MATERIALS

A. General Requirements. Provide new corrosion resistant materials that comply with the details shown on the plans and the requirements of this Item. Provide splicing kits, fiber optic cable caps, moisture/water sealants, terminators, splice trays, fiber distribution housings, fiber distribution unit, fiber interconnect housing, fiber optic jumpers, and accessories to complete the fiber optic cable system. Furnish equipment for installation, splicing, and testing.

B. Minimum Fiber Qualities. The multi-mode and single-mode fiber strands utilized in the cable specified shall conform to TIA/EIA-568-B.3 section 4 and IEEE specifications. Use fiber optic glass made by Corning or approved equal. All fiber optic cable must be manufactured by Corning or approved equal manufacturer.

C. Distances. Use 50-micron multimode fiber optic cable for lengths distances less than 1800 feet and use single-mode fiber optic cable for distances greater than 1800 feet.

D. Minimum Requirements for Fiber Optic Cable. Optical fiber cables shall be of loose buffer tube configuration. The fibers shall not adhere to the inside of the buffer tube. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

All optical fibers and buffer tubes shall be color coded per EIA/TIA-598. In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

Each buffer tube and the cable core interstices shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional non-toxic solvents.

All fibers in the cable must be useable fibers and meet required specifications. The cable provided will be new, unused, and of current design and manufacture.

Outer jacket shall be fungus resistant, UV inhibited, water resistant, and shall have a non wicking rip cord for easy removal. The outer jacket or sheath shall be free of holes, splits or blisters. Outer cable jacket will be marked with sequential foot markings.

For fiber optic cable, all text shall be at least 3MM in height at 3 feet intervals with the manufacturer name, optical cable, year of manufacture, call HCTRA (832)-590-6936, and the number of fibers. See example below.

“CORNING OPTICAL CABLE 10-2014 CALL HCTRA (832)-590-6936 144SME”

E. Mechanical Requirements.

The fiber optic cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one hour. No
water shall leak through the open cable end. Testing shall be done in accordance with FOTP-82, "Fluid Penetration Test for Filled Fiber Optic Cable."

The single-mode and multimode fiber optical cable shall consist of fibers separated into color-coded binder groups and surrounded by a polymeric core tube which is filled with a water blocking compound.

The cable shall have an overlapped armor of stainless steel that envelopes the core tube and has a rip cord. Two steel wires shall run longitudinally along the armor, diametrically opposite each other for strength members.

The cable shall comply with Bellcore, ANSI-FDDI, and Insulated Cable Engineers Association (ICEA) Standards. The cable shall be rated for exterior underground conduit, direct burial, aerial applications and shall be rodent and lightning resistant.

Assemble the groups to form a single compact core. The outer sheath jacket shall be comprised of high-density polyethylene (HDPE). The cable shall have a minimum bend radius of (10) times the diameter installed and 20 times the outer diameter during installation. The cable shall have a tensile strength of 600 lbs. minimum without changing the fiber characteristics for trunk cable and 125 lbs. for riser cable.

3. **CONSTRUCTION**

Aerial installation of fiber optic cable is prohibited unless written approval is received from HCTRA Engineering. Install fiber optic cable without changing the optical and mechanical characteristics of the cables.

Utilize available machinery, jacking equipment, cable pulling machinery with appropriate tension monitors, splicing and testing equipment, and other miscellaneous tools to install cable, splice fibers, attach connectors and mount hardware in cabinets employed with the above "Mechanical Requirements." Avoid jerking the cable during installation. Adhere to the maximum pulling tensions and bending radii as specified by the manufacturer.

Use installation techniques and fixtures that provide for ease of maintenance and easy access to all components for testing and measurements.

A. **Installation in Conduit.** Install fiber optic cable in conduits. If required, relocate existing cable to allow new fiber optic cable routing in conduits.

    When pulling the cable, do not exceed the bending radius. Use rollers, wheels, or guides that have radii greater than the bending radius. Provide separate grooved rollers for each cable when simultaneously pulling multiple cables. Use a lubricating compound to minimize friction. Use fuse links and breaks. Measure the pulling tension. Do not exceed a pulling tension of 2700N (600lbf).

    Seal conduits with a 2 part urethane after installation of cable.

B. **Cable Installation between Pull Boxes and Cabinets/Buildings.** Do not break or splice a second interconnect cable to complete a run when pulling the cable from the nearest ground box to a cabinet or building. Pull sufficient length of cable in the ground box to reach the designated cabinet or building. Pull the cable through the cabinet to coil, splice, or terminate the cable in the cabinet or building. Avoid bending the cable beyond its minimum bend radius.

    Coil and tie cable inside cabinet, building, or boxes for future splicing or termination as shown in the plans. Coat the open end of the coiled cable with protective coating and provide a dust cap.

    Install 50-feet of spare fiber cable (service loop) in each pull box prior to termination.

    Single-mode fiber cable shall not exceed 3000 meters.
C. **Splicing Requirements.** Splice fibers as shown on the plans, in accordance with TIA/EIA-568B.3, TIA/EIA-758, or as directed. All fiber splices shall be fusion spliced and the maximum fiber splice loss for single-mode and multimode fusion splices will be 0.3 dB, as shown in Table 1. All losses will be in accordance with TIA/EIA-568B.3.

Package each spliced fiber in a protective sleeve or housing. Re-coat bare fiber with a protective 8 RTV, gel or similar substance, prior to application of the sleeve or housing.

D. **Termination Requirements.** Provide matching connectors with 900 micron buffer fiber pigtails of sufficient length and splice the corresponding optical fibers in cabinets where the optical fibers are to be connected to terminal equipment. Buffer, strengthen, and protect fiber pigtails with dielectric Aramid yarn and outer PVC jacket to reduce mishandling that can damage the fiber or connection. Use epoxy style connectors and not the crimp on connectors. **Terminate single-mode and multimode fiber optic cable with LC connectors, or as directed.**

The connector pigtails/splice loss for complete connection at the patch panel in front of the terminal equipment shall not exceed a mean of 1.5 dB mated pair with a maximum loss of 0.75 dB. Maintain this loss characteristic for a minimum of 500 disconnections and reconnections with periodic cleanings. Qualify and accept connectors by the connector-to-connector mating using similar fibers.

Connectors shall meet the TIA/EIA-568B.3 fiber optic test procedures for multimode and single-mode specifications. Test connections at the patch panel and splices made between cables to pigtails with the Optical Time Domain Reflectometer (OTDR) to verify acceptable losses.

E. **Fiber Optic Accessories.**

**Rack Mount Splice Enclosures.** Provide a 19 inch rack mounted splice enclosure module to hold spliced fibers as shown in the plans.

Splice or terminate fibers inside rack mounted fiber optic splice enclosures. Provide an enclosed unit enclosure designed to support a minimum of 4 cables, with each cable having 36 fibers. Provide enclosures that support up to 72 fiber optic connectors in bulkheads.

Splice trays shall be able to accept single-mode and multimode fibers and shall be completely re-enterable and accommodate up to eight buffer tubes, expandable to 24 buffer tubes. Trays shall hold up to 48 splices expandable to 288 splices. The buffer tubes will be held in place with channel snaps. Trays will be stackable in design.

**Fiber Optic Connectors.** All multi-mode and single-mode fiber optic cable shall be terminated via ceramic tipped, pre-polished field installed, LC style connectors. The connectors will be a pull-proof design with an optical axial pull strength of 0.5lbf. The maximum optical attenuation per each mated connector pair shall not exceed 0.75 dB. The total optical attenuation through the cross-connect from any terminated optical fiber to any other terminated optical fiber shall not exceed 1.5 dB.

**Fiber Distribution Housings.** Install the cables according to manufacturer standards for the rack mount splice enclosure, fiber distribution housing, and splice trays.

Coil and protect a maintenance loop of at least 5 ft. of buffer tube inside the rack mount, fiber distribution housing, or splice tray. Allow for future splices in the event of a damaged splice or pigtails.

**Cabinet and Building.** Terminate or splice fibers inside the compact and modular fiber distribution housing in the cabinet. Provide a 9” x 17” x 11” (h x w x l) housing, each housing having 4 snap-in simplex connector panel modules, each module having 6 fiber termination/connection capabilities.
Use a pre-assembled compact modular unit snap-in simplex connector panel module, with a removable cover having 6 pre-conectorized fiber pigtails, interconnection sleeves, and dust caps installed by the manufacturer.

Provide a 12 fusion splice tray capability housing, each tray holding 12 fusion splices as shown in the plans. Stack the splice trays on a rack to permit access to individual trays without disturbing other trays. Locate the rack on a pull-out shelf. Protect the housing with doors capable of pivoting up or down and sliding into the unit.

Document the function of each terminated/spliced fiber, along with the designation of each connector on labels and charts on the housing door. Provide each housing with strain relief. Terminate multimode and single-mode fiber optic cable with LC connectors, unless otherwise shown on the plans.

**Patch Cables.** Patch Cables shall be utilized that have been submitted by the Contractor and approved by the Engineer. Only one manufacturer's connector shall be used on any one assembly or group of assemblies within a project. No splices of any type are allowed within an assembly.

Each assembly is to be 100% tested and those test results placed on a test tag for each mated pair of connectors. Connectors will then be attached to one end of each pair within the assembly. Each assembly shall be individually packaged within a plastic bag with the submitted manufacturer's part number marked clearly on the outside of the bag. Each installed patch cord shall be labeled as directed by the Engineer.

**Fiber Labeling Standards and Conventions.** Labels will be used on all fiber optic cable and fiber patch cables. The labeling scheme shall be TIA/EIA-606A compliant or better. Label materials shall meet all applicable fire codes and be resistant to the environment and have life span equal to or greater than the product to which they are applied. All labels shall be machine printed unless otherwise approved by the Engineer in writing.

Outside Plant (OSP) shall be labeled at each end of the fiber optic cable. The label shall include the far end location name, building number, single-mode or multi-mode, and the strand count. The cable shall be also be labeled at entrance and exit points of the tunnel system or if it enters a conduit. The label shall be placed between 12 inches and 36 inch from the conduit or at the closet point that it is clearly visible.

Termination panels at both ends shall be labeled with the far end building name, building number, single-mode or multi-mode, and the strand count. Termination panels shall use both machine printed labels and manufactures color coding on ferrules to denote single-mode fiber or multimode fiber.

Ferrule colors shall be yellow for single-mode and black or no color for multimode.

Each separate 6 or 12 strand panel insert shall have a factory panel label and each strands terminations shall have a factory label or installers machine printed label with the strand number for that cable. If there is a factory supplied label for the door or cover it shall be used to indicate cable numbers and strand number.

### 4. FIBER OPTIC CABLE TECHNICIAN QUALIFICATIONS

**A. Work To Be Performed By Fiber Optic Technicians.** Any task requiring the opening of the fiber optic cable jacket, installation of fiber optic connectors, fusion splicing together of two fibers, or the testing of any fiber optic cable, drop cable, or patch cords shall be performed by Fiber Optic Technicians that have been pre-approved by the Engineer.

**B. Minimum Requirements for Fiber Optic Technicians**

**Certifications** - All fiber optic technicians shall maintain Fiber Optic Installer Certification by the Electronic Technical Association (ETA). It should be noted that approved fiber optic technicians shall maintain all certifications on their person at all times while working on the subject project.
Training - All fiber optic technicians shall be able to demonstrate their participation in at least one of the following:

1) Attendance and successful completion of at least one four day "Installation of Fiber Optic Products School" conducted by a major manufacturer of fiber optic products within one calendar year of the commence work date of this project. Said course outline shall be submitted for review by the Engineer in order to determine if the course content is adequate to address the work requirements established in Section 4A.

2) Demonstration of attendance and successful completion of an independent generic four day school that encompasses all aspects of outside plant fiber optic technician certification within one calendar year of the commence work date of this project. Said course outline shall be submitted for review by the Engineer in order to determine if the course content is adequate to address the work requirements established in Section 4A.

Work History for Fiber Optic Technicians - All Fiber Optic Technicians who will perform work on this project be able to demonstrate a minimum of two years work experience, with a minimum of one (1) year continuous work experience during this timeframe. Work experience shall be any work activity involving those work elements described in Section 4A.

C. Submittals for Fiber Optic Technician Qualifications. Prior to the start of construction on this project, the Contractor shall submit to the Engineer all documentation necessary to demonstrate that all fiber optic technicians providing services on this contract meet the minimum requirements established in Section 4A and Section 4B. The Contractor understands that written approval of the technicians submitted for review by the Engineer is required prior to beginning any work on the fiber optic cable plant. It is further understood that the Contractor will address any deficiencies noted by the Engineer prior to beginning any work on the fiber optic cable plant.

5. DOCUMENTATION REQUIREMENT

Provide operation and maintenance manuals in Portable File Document (PDF) format with the following:

- Complete and accurate schematic diagrams showing the fiber optic cable system.
- Complete performance data of the cable system showing the losses at each splice joint and each terminal connector.
- Installing, splicing, terminating and testing procedures.
- Complete parts list including names of vendors.
- Complete maintenance and trouble-shooting procedures.

Installation Practice. Submit for approval the Contractors Installation Practices in Portable File Document (PDF) format thirty working days prior to installation. Submit practices for approval, which includes practices, list of installation equipment and splicing and test equipment. Detail field quality control procedures and corrective action procedures.

Manufacturer’s Certification. Accompany each reel of fiber optic cable with the manufacturer’s test data showing the conformance to the requirements in this Item.

6. TESTING

The installing contactor shall perform fiber optic testing on all installed fiber optic cabling. Testing will consist of:

- fiber acceptance test,
- post installation test and,
- post termination test.
All documented test results shall be provided to the Engineer for review and approval. The contractor shall submit these forms with all required information no later than 10 days after the cables are tested. The contractor shall provide calibration certifications for testing equipment to be used. The contractor shall submit these certificates to the Engineer with all required information, prior to commencement of testing.

A. **Link Attenuation (OTDR).** Horizontal cables shall be tested for dB loss and end-to-end total installed distance with an OTDR. Each trace shall indicate the cable length and dB loss. All OTDR traces shall be tested bi-directional, from and through the first connector pair (test location) to the termination patch panel, at 850 nm and 1300 nm for multimode cable and at 1310 nm and 1550 nm for single mode cable. All OTDR traces shall be accomplished using a manufactured and terminated Corning MM/SM, as appropriate, glass launch cable that is 100m for multimode and 200m for single-mode and using the correct fiber type and core size. Launch cable cannot be made in the field, must be factory made. All OTDR traces shall be accomplished using the Medium Smooth setting. All OTDR traces shall indicate test readings taken in meters. All OTDR test traces shall indicate a 2-Point dB loss between the A and B test trace cursors (showing test location and end fiber optic patch panels).

B. **Link Attenuation (Power Meter)** All horizontal multimode and single-mode fiber optic cables shall be tested for link attenuation (i.e. power insertion loss, power meter test) as referenced in TIA/EIA-568-B.3. All strands shall be tested in a bi-directional method with a Power Source and Meter. All fiber optic cables, to include connectors, shall be tested in-line between two reference cables. One cable shall be attached to the light source and the other to the power meter to measure the dB loss from both connectors, as well as, any dB loss associated with the cable between the connectors. The TIA/EIA 568B.3 and TIA/EIA 526-7 standards outlines the steps required to test single-mode fiber optic cable. All fiber optic cables shall be tested from each end at both wavelengths 1310nm and 1550nm. Ensure that all connectors (on both sides of the mating sleeve) are clean prior to testing. Do not use canned air to clean the connectors or mating sleeves. Some canned air products can leave a fluid buildup and/or create a static charge. Once all fiber strands are tested, reverse this procedure and retest. The light source should not be disturbed once the testing begins. Provide tester-generated documentation.

C. **Test Documentation.** All fiber test results for power meter and OTDR shall be documented on both paper and CD (electronic copy) that is readable by Fluke LinkWare software of contain PDF files. A copy of the transmittal letter explaining any issues regarding the test results not meeting the requirements shown in Table 1 (skipped numbers, cause of failures, etc.).

### Table 1

<table>
<thead>
<tr>
<th>Maximum Loss Measurements for Installed Fiber Optic Cables</th>
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<tbody>
<tr>
<td>Mated Connector Loss:</td>
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<tr>
<td>1.5 dB per mated pair</td>
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<tr>
<td>Connector Loss:</td>
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<tr>
<td>0.75 dB per connector</td>
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<tr>
<td>Splice Loss:</td>
</tr>
<tr>
<td>Fusion Multimode:</td>
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<tr>
<td>0.3 dB</td>
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<tr>
<td>Fusion Single-mode:</td>
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<tr>
<td>0.3 dB</td>
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<tr>
<td>Mechanical:</td>
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<tr>
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<tr>
<td>Fiber Loss:</td>
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<tr>
<td>Multimode 50-micron</td>
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<tr>
<td>3.5 dB/km @ 850 nm</td>
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<tr>
<td>1.5 dB/km @ 1300 nm</td>
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<tr>
<td>Single-mode:</td>
</tr>
<tr>
<td>0.4 dB/km @ 1310 nm</td>
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<tr>
<td>0.3 dB/km @ 1550 nm</td>
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The CD shall have a computer generated label with:
- Contractors name
- Date
- HCTRA fiber location address
- Contents (fiber test results, etc.)
7. **TRAINING**

Perform training in accordance with Item 6005, Article 3, “Testing, Training, Documentation, Final Acceptance, and Warranty.” Include the following training material: code compliance, pulling and installation techniques, use of installation tools, splicing and terminating equipment and test instruments, and methods of recording installation and test data. Furnish training material in Portable File Document (PDF) format 30 days before training begins for approval.

8. **WARRANTY**

Provide a warranty in accordance with Item 6005, Article 6, “Testing, Training, Documentation, Final Acceptance, and Warranty.”

9. **MEASUREMENT**

This Item will be measured by the foot of cable furnished, installed, spliced, connected, and tested.

10. **PAYMENT**

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Special Fiber Optic Cable” of the type, and number of fibers as applicable. This price is full compensation for furnishing and installing all cable; for relocating cables as required; for pulling through conduit or duct; testing; splicing; connecting; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.