

SECTION 16121

FIBER OPTIC CABLE AND ACCESSORIES

PART 1 – GENERAL

1.1 Summary

A. This section includes the components and fiber optic cable necessary to provide a network Connection as indicated. The components include single-ended fiber optic network. The fiber optic cable between transreceivers and the fiber optic network. The fiber optic cable includes cable intended for outdoor installation in a buried conduit system and factory assembled fiber optic jumpers for interconnections inside cabinets. Accessories include fiber optic connectors and termination kits.

B. Related Work Specified Elsewhere

1.2 Quality Assurance

A. **Reference Standards and Specifications:** Design, fabricate, assemble and test material so as to conform with all applicable codes and standards including, but not limited to the following:

1. National Electrical Code (NEC)
2. Underwriter's Laboratories, Inc. (UL)
3. Insulated Cable Engineer's Association (ICEA)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. Electronic Industry Association (EIA)
 - RS-455
 - TIA-568A, "Commercial Building Telecommunication Cabling"
6. Bellcore TR20, "Generic Requirements for Optical Fiber and Optical Fiber Cable"
7. Rural Electrification Agency (REA) PE-345-90, "Totally Filled Fiber Optic Cable"

B. Factory Test

1. **Quality Control Test Protocol:** The manufacturer shall conduct test according to industry standard requirements. These tests shall be performed routinely on sample sizes sufficient to verify quality and continuity or as specified.
2. The end-to-end attenuation of each reel of cable supplied shall be tested. All of the fibers per reel shall be tested. The results shall be recorded and provide with the cable when shipped. A copy of these test reports shall be submitted to Engineer.

3. Test shall be performed on this or similar cable construction by the manufacturer and the cables shall meet or exceed the requirements of the standard specified. Copies of the reports shall be submitted for the following test:
 - a. Crush Resistance: Test with acceptable results shall be performed on similar cable types in accordance with EIA-455-41. The cable shall have a compressive strength of 1350 lbs, at 20°C.
 - b. Impact Resistance: The impact test specified in EIA-455-25A will show that no significant attenuation will result from 25 impacts of the specified force at a sample temperature of -30°C or +25°C.
 - c. Cyclic Flex Resistance (Test Conditions I and III): No significant attenuation results after 25 flex cycles when tested in accordance with EIA-455-104 using a bend radius of 5 times the cable outside diameter.
 - d. Temperature Cycling: Conduct in accordance with EIA-455-3A. The results show no attenuation increase at -40°C and -70°C.
 - e. High and Low Temperature Bend Resistance (Test Level 1): No significant attenuation shall result from testing in accordance with EIA-455-37 at test temperatures of -30°C or +60°C.
 - f. Water Penetration: The cable shall meet the requirements of EIA-455-82B.
 - g. Compound Flow (Drip) Resistance: Test results shall indicate compliance with the requirements of EIA-455-81 at the temperature of +60°C.
 - h. Tensile Loading: Test with acceptable results shall be performed on this or similar cable types in accordance with EIA-455-33. Results shall meet or exceed manufacturer's published results for tensile strength.

C. Site Test

1. Upon delivery of the cable to the specified location, the Contractor shall perform acceptance testing. This testing shall include continuity testing with a light source, and visible inspection for crushing.
2. Any visible damage to the cable construction should be brought to the Engineer's attention immediately.

1.3 Submittals

- A.** Submit to Lake Havasu City Information Systems Division.
- B.** Includes, but not limited to, the following:
 1. Data sheets for each cable type and cable accessory specified.
 2. Manufacturing, testing, and delivery schedule.

3. Cable manufacturer's approval of splicing and terminating materials.
 4. Cable manufacturer's approval of pulling compounds.
 5. Cable manufacturer's installation requirements such as maximum pulling tensions, sidewall pressures, minimum bending radii, reel dimensions, etc.
 6. Instruction Manuals for Fiber Optic Data Interface.
 7. System architecture drawings with system optical loss budget.
 8. Other equipment and materials to be used.
 9. One (1) 3 foot sample of fiber optic cable.
- C. Submittals shall include:**
1. A sketch of the proposed communication system. Provide a brief description of the topography of the system and its operation.
 2. Identify all components on the proposed communication system and provide catalog cut sheets for each component including:
 - a. Fiber optic data interface modules. Include optical gain.
 - b. Fiber optic cable.
 - c. Fiber optic jumpers.
 3. Provide an optical loss budget for each circuit indicated on the Bidder's Communication System Architecture sketch. The optical loss budget for any circuit shall not exceed the optical gain on that circuit. The optical loss budget shall include:
 - a. Fiber optic cable loss as specified (dB/km) with distances as indicated.
 - b. Each connector mated pair shall be considered as 0.75 dB.
 - c. Each splice shall be considered as 0.3 dB.
 - d. An additional 3 dB of loss shall be allocated for system design margin.

PART 2 – MATERIALS

2.1 Acceptable Manufacturers

A. Cable

1. AT&T-FITEL.
2. Cablec-Brand REX.
3. Furon-Dekoron Division.

4. Pirelli.
5. Siecor Corporation.
6. Chromatic Technologies.

B. Fiber Optic Duplex Jumpers

1. Siecor Corporation.
2. Engineer Approved Equal.

C. Cable Accessories

1. Cable Connectors for Fiber Optic Cable
 - a. AMP Special Industries.
 - b. AT&T.
 - c. Minnesota Mining and Manufacturing (3M).
 - d. Siecor Corporation.
2. Termination, Splice and Hardwar Kits
 - a. Amp Special Industries.
 - b. AT&T.
 - c. Minnesota Mining and Manufacturing (3M).
 - d. Siecor Corporation.
3. Tape
 - a. Minnesota Mining and Manufacturing (3M)
4. Cable Ties
 - a. Amp Special Industries.
 - b. Dennison Manufacturing Company.
 - c. Minnesota Mining and Manufacturing (3M).
 - d. Panduit Corporation.
 - e. Thomas and Betts Company, Inc.
5. Cable Supports
 - a. O.Z. Gedney Company.

D. Fiber Optic Data converter Modules

1. Weed Instrument Co. (Weed).

2. Phoenix Digital (Phoenix).
3. Allen-Bradley.
4. Engineer Approved Equal.

2.2 Fiber Optic Cable

A. General

1. Cables shall be breakout style design
2. Cables shall contain multimode fibers in number indicated
3. Cable shall have a central anti-buckle element of fiber reinforced plastic. One or more layers of torque balanced aramid yarn shall be applied helically over the inner tube bundle.
4. At least one but not more than twelve color coded buffer tubes shall be stranded around central strength element. Each tube shall be made of high modulus plastic and contain at least one but no more than six individually color coded optical fibers. Each buffer tube shall be filled with an anti-oxidant non-hygroscopic, non-nutritive to fungus, electrically neutral, homogeneous gel to prevent water intrusion and migration. The cable shall contain filler rods, with an identical diameter as the buffer tube, as required to maintain a circular cross section of the cable.
5. Outer jacket shall be Polyethylene "PE" (ICEA S-66-524 Part 3)
6. Surface printing on the cable shall show manufacturer's name, jacket types, number of conductors, numbered footage markers, and the words "Fiber Optic Cable" or "Optic Cable." The markings shall be in contrasting color to cable jacket.
7. Cable operating temperature range (long term and storage) shall be from -40°C to +70°C (-40°F to +158°F).
8. Standard factory test shall be performed on all cable.
9. All cables supplies shall meet the flame test requirements of IEEE 383 using a gas burner flame source
10. Cables shall be certified to be in conformance with all applicable requirements of ICEA s-66-524, and EIA RS-455.

B. Optical Fibers

1. Provide Corning multimode optical fibers.
2. Each fiber shall have a mechanically strippable color-coated acrylate protective coating.
3. The entire fiber length per reel shall be unspliced and subjected to a tensile proof stress test equivalent to 100 kpsi for 1.0 second dwell time.

4. Optical Fiber Parameters: The following specifications represent minimum values.
 - a. Shall be multimode graded index with 62.5/125/250 um fiber/cladding/buffer diameters. Shall have numerical aperture of 0.275 or less.
 - b. **Fiber Attenuation and Bandwidth**
 - Optical Wavelength 850 1300nm
 - Maximum Attenuation 3.75 1.50 dB/km
 - Minimum Bandwidth 160 500 MHz-km

2.3 Shipping and Handling

A. Cable Packaging

1. Each cable reel will hold only one continuous cable.
2. Reel Identification Numbers
 - a. Each cable reel shall have a unique identification number.
 - b. Reel identification shall be placed on one of the end flanges and using one of the following methods:
 - 1) Permanently stenciled ½ inch letters
 - 2) Corrosion- resistant metal tag, minimum size shall be 3 inches by 5 inches with ¼ inch stamped letters
 - c. Reel identification shall include the following:
 - 1) Project name
 - 2) Contract number
 - 3) Cable type including manufacturer's part number and configuration/fiber count.
 - 4) Starting and ending cable footage marker number
 - 5) Reel gross and net weight
 - 6) Reel identification number (unique for each reel)
3. Cable End Preparations: Each cable end shall be sealed with a rubber cap or other approved method to prevent moisture entry.
4. Manufacturer shall provide, as a minimum, a two-layer pressed fiberboard cover around the outside of the cable for each cable reel.
5. Reels shall be shipped with both end flanges in the upright position and secured to prevent damage to the cable.

2.4 Fiber Optic Duplex Jumper

- A. Two fiber cable with zipcord cable design, riser – OFNR rated.
- B. Fiber shall be 62.5/125 um, multimode, graded index with ST type connectors factory installed on each end of each fiber.
- C. Manufacturer shall be Siecor #25 25 02K5141 or Engineer approved equal.

2.5 Fiber Optic Data Converter Modules

- A. General:** The Fiber Optic Data Converter Modules shall provide a transparent interface between the Transit Building and the router located in the Public Works Maintenance Facility using the fiber optic cable network indicated. The modules shall convert the electric signals to light at one end, and back to electric at the other end.
 - 1. Power Supply: 120Vac +/- 10%, 60Hz
 - 2. Operating Temperature Range: 0°C to 60°C
 - 3. Optical Interface: Shall interface with specified 62.5/125 um multimode fiber and operated at a wavelength of 1300 nm. Shall use ST connectors with one fiber for transmit and one fiber for receive.
 - 4. Electrical: Shall interface with the data using the vendor's standard network connector and data cable.
 - 5. System operation shall be transparent to network, retaining full speed and all operational features of the network. Failure of any one circuit shall not affect the operation of the rest of the network.
 - 6. Coordinate with the transreceiver as specified in low voltage sheet 3 of 3.
 - 7. Shall interface a router data port to the fiber optic network through a single optical duplex port.

2.6 Accessories

A. Connectors

- 1. Field Installed Connector
 - a. Connector shall be SC type and size to accept specified fiber.
 - b. Provide fanout kits and loose tube furcation kits to seal the loose tube cable at the termination point.
 - c. Maximum losses shall be 0.6 dB per coupled pair.

B. Cable Supports

- 1. Cable supports for cables in vertical conduit risers or vertical tray, with considerable weight of cables shall be O.Z. Gedney Type "R" wedging plug type or approved equal.

C. Cable Ties

1. Nylon self-locking type.
2. Normal service temperature range of -40°C to +85°C.
3. Weather-resistant type for outdoor use.
4. Conforms to Military Specifications MIL-S-23190D.
5. AMP Special Industries "AMP-TY," Dennison Manufacturing Company "BAR-LOK," Pandduit Corporation "PAN-TY," or Thomas & Betts "TY-RAP," or Minnesota Mining and Manufacturing 3M Brand cable ties.

D. Cable Identification Tags

1. Designed to provide a permanent wire and cable identification system.
2. Show complete cable number.
3. Cable numbers shall be machine printed, legible, and permanent.
4. Character size for cable numbers shall be a minimum of 1/8 inch.
5. Materials shall be nonmetallic and impervious to moisture.
6. Be securely attached to cables and accessible for inspection.
7. Cable identification tags, marking and attachment methods shall be subject to approval of the Engineer.

PART 3 – EXECUTION

3.1 Installation

A. General

1. Contractor shall develop a cable tagging scheme and label each cable. Contractor shall record each cable number and identify it on the System Architecture drawing along with the color of each fiber. This information shall be provided as part of the "as-constructed" documentation.

B. Cable

1. General Requirements

- a. Provide crushed rock laydown area for cable storage. All reels shall be stored in the upright position off the ground on timbers.
- b. Contractor shall exercise due caution during installation of the fiber optic cable to prevent damage to glass fibers.
- c. Install in conduit as indicated.
- d. Do not subject cable to pulling tensions or sidewall pressures in excess of manufacturer's recommendations.

- e. Attach pulling grips around the cable diameter. Sufficient slack should be provided to cut off several meters of cable after it is in place.
- f. Do not subject cable to bending radius less than those recommended by the cable manufacturer.
- g. Install intermediate splices only as indicated. All cable splices must be approved by Engineer prior to installation in order to prevent unexpected signal attenuation. Cable splicing locations shall be approved by Engineer prior to cable installation.
- h. Support cables at connections or termination points such that any strain on cable will not be transmitted to the connection or termination.
- i. Install cable supports in vertical runs of tray or conduit, at boxes and at terminations in equipment, and as required to meet intermediate support requirements of National Electrical Code (NEC).
- j. All pull boxes, splice panels, and termination cabinets shall be clearly identified as containing fiber optic cable.
- k. All pull box or junction box locations must be approved by Engineer and Owner prior to installation.
- l. All pulling compounds shall be approved by cable manufacturer as being compatible with cable materials.
- m. Attach a cable identification tag to each cable at all termination or end points.
- n. Contractor must provide a load cell tension monitoring device to aid in assuring that cable pulling tension limits are not being exceeded. In addition, the Contractor shall monitor and record individual cable pulls as requested by the Resident Project Representative to assure compliance with the cable limitations as published by the cable manufacturer. Use W.C. Dillion and Company equipment or approved equal.
- o. All installation shall comply with the applicable parts of the National Electrical Code (NEC),
- p. There shall be at least 12 feet (or more as specified by Engineer) of excess fiber optic cable remaining at all terminations for the purpose of making connections, splices or test.
- q. Cable and/or fiber identification markers shall be installed at each splice.
- r. Tie together with cable ties all single conductor cable on each individual circuit in each junction box, equipment or manhole, and in cable tray, at intervals not to exceed 6 feet.

C. Cable Connectors, Terminations, and Splices

1. Contractor shall provide a qualified technician to make all connections, terminations, and splices with the fiber optic cable as specified.
2. All cable connections, terminations, and splices shall be made according to manufacturer's instructions.
3. Make only in terminal boxes, equipment or other accepted enclosures and not in conduit or cable tray.
4. Install all connectors with manufacturer's approved tooling.
5. All fiber optic cable splices shall be performed with fusion splicer. The spliced cables shall be attached to a splice tray mounted inside an approved enclosure.
6. All splices and splice locations must be approved by the Engineer.
7. All cables to be spliced must be tested after installation but prior to splicing to establish losses.
8. All splices shall be tested and test results submitted to Engineer for approval.
9. No spliced cables shall be pulled. Only cables that have been installed and are under no tension shall be spliced.
10. Fiber/conductor color coding shall be maintained.
11. Cable identification markers shall be installed at each splice or connection.
12. Splice to be covered with color coded tube.

D. System Tests

1. After installation and prior to splicing, the Contractor shall use a high resolution OTDR to test each fiber of the fiber optic cables. Printed copies of the OTDR traces shall be submitted to the Owner and Engineer for acceptance of the installation.
2. After installation and prior to connection, the Contractor shall use a high resolution OTDR to test each fiber with connectors from end connector to end connector. Measure the bidirectional average attenuation at 850 nm. Printed copies of the OTDR traces shall be submitted to the Owner and Engineer for acceptance of the fiber optic cable system.
3. Any excessive losses due to installation, splices, etc., shall be identified and corrected by the Contractor and tested with no additional charge.
4. After acceptance of fiber optic cable system, all additional components (including fiber optic data converters and fiber optic jumpers) shall be installed and operation of the complete system tested. Test data shall be supplied to the Owner and Engineer for acceptance of the system.

PART 4 – MEASUREMENT AND PAYMENT

A. Measurement: No measurement will be made.

B. Payment

A. Electrical Upgrades: No payment will be made for labor and materials to complete the electrical upgrades.

B. Fiber Optic Cable and Accessories

Payment for the fiber optic cable and accessories will be made at the Contract Lump Sum Price Bid and shall be considered full payment for providing the labor and materials to perform this work.

END OF SECTION.