SECTION 17384

FIBER OPTIC CABLE SYSTEM

# GENERAL

## REQUIREMENT

### The CONTRACTOR shall provide and install fiber optic cable and fiber optic components complete and operable, in accordance with the Contract Documents.

### The requirements of 17000 -General Requirements for IC Systems apply to this section.

### Due to the complexities associated with fiber optic cable, it is the intent of these specifications that the Electrical CONTRACTOR through the Fiber Optic Installer be responsible to the CONTRACTOR for the installation of the fiber optic cable. The CONTRACTOR shall submit for the DISTRICT’s approval the experience history of the Fiber Optic Installer to demonstrate that the following minimum criteria are met.

#### Submit documentation of proof to show that the persons responsible for the installation of the fiber optic cable have been formally trained in the installation of fiber optic cable and have a minimum of three years of experience in the installation of fiber optic cables.

#### In addition, list the following information of the experience of the fiber optic installation technicians:

##### Name of plant, District, contact name, and telephone number of at least three projects where fiber optic cable was installed.

##### Type of equipment installed: manufacturer and model numbers.

##### Date of completion or acceptance.

#### The Fiber Optic Installer shall be a member in good standing with the Corning Network of Preferred Installer (NPI) program and shall submit a 25-Year Corning Cable Systems LANscape Solutions Extended Product Warranty, commencing at the time of final acceptance.

##### The cable manufacturer shall be ISO 9001 registered.

## REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

### The Work of the following Sections applies to the Work of this Section. Other Sections, not referenced below, shall also apply to the extent required for proper performance of this Work.

#### Section 01300 Submittals and Shop Drawings

#### Section 17300 Instrumentation Control and Monitoring System

#### Section 16010 General Electrical Requirements, General

### Except as otherwise indicated, the current editions of the following standards apply to the Work of this Section:

#### American Society for Testing and Materials (ASTM)

##### ASTM D 3350 – Polyethylene Plastics Pipe and Fittings Materials

##### ASTM D 2239 – Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

#### Department of Defense (DOD) Fiber Optic Test Method and Instrumentation

##### DOD-STD-1678 – Military Standard Fiber Optics Test Methods and Instrumentation

#### Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

##### EIA-STD-RS-455 – Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices

##### EIA/TIA-492 AAAA – Detail Specifications for 62.5 Micron Core Diameter 1125 Micron Cladding Diameter Class Multimode, Graded Index Optical Waveguide Fibers

##### EIA/TIA-568A – Commercial building wiring standard

##### EIA/TIA-569B – Commercial Building Standard for Telecommunications Pathways and Spaces

##### EIA/TIA-598A – Optical Fiber Color Coding

##### TIA-455-82B – FOTP-82 Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable

#### Institute of Electrical and Electronics Engineers (IEEE)

##### IEEE Standard 383 – Flame Retardancy

#### National Fire Protection Association (NFPA)

##### NFPA 70

#### Underwriters Laboratories, Inc. (UL)

##### UL 910 – UL Standard for Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air.

##### UL 1581 VW-1 – Vertical Tray Cable Flame Test

##### UL 1666 – UL Standard for Safety Test for Flame-Propagation Height of Electrical and Optical-Fiber Cables Installed in Vertical

### Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

## Contractor SUBMITTALS

### Shop drawings shall conform to the requirements of Section 01300 – Shop Drawings and Submittals. Submittals shall include the following:

#### Complete manufacturer’s product data. Product data shall be provided for the fiber optic cables, connectors, patch panels, spares and test equipment. Product data sheets shall include the manufacturer’s name and catalog number for each item, the manufacturer’s descriptive literature, catalog cuts and any power supply requirements.

#### Certification of compliance in writing stating the fiber optic cable, anticipated layout, and components are compatible, acceptable for use and in compliance with these specifications.

#### Complete layout and installation proposed which shows cable and innerduct/conduit routing, materials, cable size and type, pulling lubricant being used, installation details, estimated maximum pulling tensions, overall system losses for each fiber, and any and all patch panel locations.

#### Resumes of the certified installation personnel who will actually conduct and supervise the installation.

#### Training plan and schedule for fiber optic cable termination training.

#### Installation Test reports as specified.

#### Provide four samples of each type of cable and connector termination kit. Four samples of a completed example of each type of connector termination shall be submitted. Each sample cable shall be at least 6 feet long.

#### Provide a fiber optic power budget for each cable run in excess of 500 feet. The budget shall include transmitter power, receiver sensitivity, connector losses, cable losses and a 3-dB (decibels) aging margin. Fiber optic transmission line shall maintain a minimum of 3-dB safety margin.

#### Manufacturer’s Instructions.

## PRODUCT DELIVERY, STORAGE AND HANDLING

### The cable shall be packaged in cartons and/or wound on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

### When the length of an order requires a large wooden reel the cable will be covered with a 3‑layer laminated protective material. The outer end of the cable shall be securely fastened to the reel head so as to prevent the cable from becoming loose in transit. The inner end of the cable shall project into a slot in the side of the reel or into a housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.

### Test tails shall be at least 2 meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation. Reels shall be permanently marked with an identification number that can be used by the manufacturer to trace the manufacturing history of the cable and fiber.

### Wooden reels shall be plainly marked to indicate the direction in which it should be rolled to prevent loosening of the cable on the reel.

### The attenuation shall be measured at 1300 nm for multimode fibers. The manufacturer shall ship the test results along with the fiber.

### Packaging

#### The completed cable shall be packaged for shipment on nonreturnable wooden reels. It is the responsibility of the CONTRACTOR to determine all required cable lengths.

#### Top and bottom ends of the cable shall be available for testing.

#### Both ends of the cable shall be sealed to prevent the ingress of moisture.

#### Each reel shall have a weatherproof reel tag attached identifying the reel and cable.

#### Each cable shall be accompanied by a cable data sheet.

## RECORD DRAWINGS

### Record drawings shall be provided in accordance with 17000 -General Requirements for IC Systems.

# PRODUCTS

## FIBER OPTIC CABLE

### Cable Specifications

#### General: Cable shall be ultraviolet (UV) resistant and fully water blocked for use in indoor/outdoor applications. Cable shall be suitable for installation in duct, aerial, and riser environments. Cable shall meet UL optical fiber non-conductive riser (OFNR) specifications and shall not require transition splicing upon building entry in order to meet fire codes. The cable shall be the manufactured by Corning Cable Systems, Optical Cable Corporation, Belden, or approved equal.

#### Optical fibers shall be placed inside a buffer tube. Each buffer tube shall contain 12 or 24 fibers (as indicated on design documents). Each fiber shall be distinguishable by means of color coding according to TIA/EIA-598-A. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors according to TIA/EIA-598-A. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other. Colors shall not cause fibers to stick together. Buffer tubes shall be kink resistant within the specified minimum bend radius.

#### Fillers may be included in the cable core to lend symmetry to the cable cross-Section where needed. The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.

#### The cable core shall contain a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional non-toxic solvents. Cable shall contain water blocking threads between tubes.

#### Summary of Specifications

##### Fiber Optic Cable (Multimode):

###### Corning Freedm / LST, Indoor / Outdoor OFNR

###### Number of Fibers: 12 or 24 (as indicated on contract documents)

###### Model No. (12 fiber): 012KSF-T4130D20

###### Model No. (24 fiber): 024KSF-T4130D20

###### Flame Retardant: Yes

###### Fiber Material: Glass (Corning Fiber)

###### Fiber Type: Graded Index

###### Fiber Core Diameter: 62.5 Micron

###### Mode: Multimode

###### Cable Attenuation: 3.4/1.0 dB/km at a wavelength of 850/1300 nm

###### Maximum Cable Outside Diameter (12 fiber): 0.29 inch

###### Maximum Cable Outside Diameter (24 fiber): 0.38 inch

###### Minimum Bend Radius (12 fiber): 4.4 Inches Installation; 1.5 Inches Operation

###### Minimum Bend Radius (24 fiber): 5.7 Inches Installation; 3.8 Inches Operation

###### Maximum Tensile Strengths: 300 lb-f Short-Term; 90 lb-f Long-Term

##### Fiber Optic Cable (Single-mode):

###### Corning Freedm / LST, Indoor / Outdoor OFNR

###### Number of Fibers: 24

###### Model No.: 012ESF-T4101D20

###### Flame Retardant: Yes

###### Fiber Material: Glass (Corning Fiber)

###### Fiber Core Diameter: 8.2 µm

###### Mode: Single-mode

###### Cable Attenuation: 0.4 dB/km at a wavelength of 1310/1383 nm; 0.3 dB/km at 1550 nm

###### Nominal Outer Diameter: 0.29 inch

###### Minimum Bend Radius: 4.4 Inches Installation; 1.5 Inches Operation

###### Maximum Tensile Strengths: 300 lbf Short-Term; 90 lbf Long-Term

##### **Fiber Connectors:** The Connectors shall be field installable with the following specifications:

###### **Type:** LC

###### **Attenuation:** 0.2 dB (not to exceed 0.5 dB)

###### **Tensile Strength:** 11 lb ≤ 0.2 dB change on jacketed cable exceeds

###### **Operating temperature:** –40° to 75°C

###### Construction: Ceramic

###### The connectors shall be Unicam Pretium-Performance Multimode, part number 95-000-99 by Corning

### Cable Performance

#### When a one meter static head or equivalent continuous pressure is applied at one end of a one meter length of unaged cable for 24 hours, no water shall leak through the open cable end. When a one meter static head or equivalent continuous pressure is applied at one end of a one meter length of aged cable of one hour, no water shall leak through the open cable end. The aging cycle is defined as exposing the cable to +85 degrees ±2 degrees C for 168 hours and two cycles of –40 degrees C to +70 degrees C with cable held at these temperatures for 24 hours. The water penetration test is completed at the end of the 24-hour hold. Testing shall be performed in accordance with the industry-standard test, TIA-455-82B.

## PATCH PANELS

### General: Patch panel shall be provided by the CONTRACTOR at fiber optic cable termination locations.

### The patch panel shall be Corning CCH-01U with two 12 fiber Corning connector housing panels with LC Duplex for 62.5 Micron multimode fiber. Corning model CCH-CP-12-A8 or approved equal.

### Provide patch cords to connect the fibers from the fiber patch panels to the switches and to interconnect fibers within the patch panels. Patch cords shall be type Corning Cable Systems 727202G5120xxxF (xxx = length in feet).

### All fibers shall be terminated, connected and labeled.

## SPARE FIBER CABLES

### Provide a minimum of 3000 feet of each type of fiber optic cables used in the project for no additional costs to the District.

# EXECUTION

## GENERAL

### Provide all material, equipment and labor to install and test the fiber optic cables as indicated and as specified.

### Installation shall be in accordance with the National Electric Code.

### Installation shall comply with EIA/TIA 568 and 569.

### Fiber optic cables shall be continuous from component to component as shown on the Drawings. Intermediate fiber splices shall not be allowed.

## INSTALLATION

### All cables shall be installed in conduit or innerduct.

### Inspect raceway prior to pulling cables. Notify the ENGINEER of any conditions which would prevent installation of the specified cables, before proceeding with the installation. Rod and swab out ducts prior to installing cables.

### Pull cables prior to attachment of connectors.

### Pull cables by directly pulling only on the strength member.

### Lubricate cables with lubricants specially formulated for fiber cabling jackets during installation. Do not exceed cable manufacturer’s specifications for tensile strength and bending radius. Pulleys used to aid in the installation of the fiber optic cable must be sized according to the minimum bending radius. The pulling tension of all fiber cables during installation shall be recorded using a strip recorder. The printout of the strip recorder shall be submitted to the ENGINEER.

### Provide breakout kits, signal transceivers, patch panels, pigtails and jumpers as required and as indicated to install a complete data highway communications link.

### Support cables in riser conduits at intervals as required by National Electric Code.

### Installation tools and materials shall be approved by the cable manufacturer.

### Within manholes, protect cable by providing flexible, corrugated, polyethylene slit duct. Connect slit duct to duct bank by using hose clamps. Support duct at 10‑foot intervals.

## IDENTIFICATION

### Label each termination point.

### Tag each cable in junction boxes, manholes and hand holes. Provide permanent nylon/plastic tie-wrap type tags with waterproof markings.

### Label each cable, buffer tube and fiber with permanent waterproof typewritten tags.

## PHYSICAL CHECKOUT

### General Procedures:

#### Conduct physical checkout of the fiber optic network.

#### Physical checkout shall be performed prior to functional testing.

### Check Procedures:

#### Verify that fiber optic cable reels have been off-loaded from truck carefully and not damaged.

#### Submit to the ENGINEER all test data provided by the fiber manufacturer.

#### Verify that the optical fibers of the cable assembly are the type and quantity as specified and as recommended by the Instrumentation Subcontractor.

#### Verify that cable construction is the type specified.

#### Verify that fiber optic patch panels have been installed plumb and level at locations indicated.

#### Verify that optical fiber connections or terminations within patch panels and splice closures are in accordance with cable manufacturer’s recommendations.

## FIELD AND FUNCTIONAL TESTING

### Make the following site tests before removing cable from cable reels:

#### Determine that attenuation losses of each fiber from end to end are less than the specified maximum attenuation. Use an optical time domain reflectometer (OTDR) to capture and record. Provide a printout of the captured data. OTDR shall be laser precision, portable, latest model by Agilent Technologies.

#### Submit to the ENGINEER all test data and models of test equipment, calibration standards and tests.

### Make the following field tests after cable and connector installation:

#### All fiber optic cables shall be tested for performance and loss after cable installation and connector termination to certify that at least a 3-dB power safety margin is obtained between all transmitters and receivers, and that fiber attenuation is not greater than specified. Test data for each fiber and safety margin calculations for each fiber path shall be provided to the DISTRICT and ENGINEER after installation to verify conformance with this specification. The following tests shall be performed as a minimum:

##### Visually, inspect terminal connectors for out-of-round condition and surface defects such as micro-chips and cracks using a 200X (minimum) inspection microscope.

##### Check optical continuity of each fiber from terminal to terminal. Use test equipment as specified herein and provide typewritten report certifying each fiber in every cable.

##### Verify the calculated attenuation power losses of each fiber from both the transmit and receive terminals of each data communications loop (both directions). The light source and operating wavelength of the test equipment shall be representative of the actual operating equipment. Use an OTDR. Test each communications loop within the patch panel and jumpers included.

##### Submit to the ENGINEER all test data and models of test equipment, calibration standard and tests.

### The DISTRICT and/or ENGINEER may observe testing. Inform DISTRICT and ENGINEER of testing schedule at least one week prior to start of testing.

### If any of the fibers fail the testing performed when the cable is on the reel, the reel shall be replaced at the CONTRACTOR’s expense, and the specified test shall be performed on the new reel. If any fiber in an installed length of cable fails the test, the cable length shall be removed and replaced with no splices at the CONTRACTOR’s expense, and the replacement cable shall be tested as specified.

### Following testing of the optical performance of the fiber optic cable, communication testing shall be carried out as specified in Section 17300 - Instrumentation Control and Monitoring System.

## TRAINING

### Provide half-day training for up to three operators on termination techniques and testing prior to installation.

### Provide training as soon as possible following submittal of proposed fiber optic cable.

## WARRANTY

### The CONTRACTOR shall submit a 25 years Corning Cable Systems LANscape Solutions Extended Product Warranty certificate from the equipment manufacturer commencing at the time of final acceptance by the DISTRICT.

END OF SECTION