**MASSACHUSETTS BAY TRANSPORTATION AUTHORITY**

**WIDETT LAYOVER FACILITY**

*Contract No.: F60PS01*

# Fiber Optic Cable

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|---|---|---|---|
| **Material Summary** | **Item** | 96-Strand Outdoor Fiber Optic Cable | 12-Strand Outdoor Fiber Optic Cable |
| | **Name** | Fiber Optic Cable System | Fiber Optic Cable System |
| | **Spec No.** | 16749P | 16749P |
| | **Quantity** | 7,000 | 11,000 |
| | **Unit** | LF | LF |

**Delivery:**

- FOB to 100 Foodmart Road, Boston, MA 02118
- Delivery is within the Project limits, which is defined as the MBTA owned property within Widett Circle
- **Delivery: By September 2, 2027**
- Materials will be at manufacturer's risk until accepted by the Authority.
- Materials rejected for non-compliance with these specifications will be returned and replaced at Manufacturer's expense within one month

**Submittal:**

- Prior to manufacture, the manufacturer shall submit complete shop drawings for each item.

# SECTION 16749P

# FIBER OPTIC CABLE SYSTEM

## PROCUREMENT ONLY

This work consists of activities relating to the fiber optic cable system procurement, specifically the long lead item fiber optic cable, (SUPPLIER) (This Contract) and installation and final testing (CONTRACTOR) (separate contract).

The SUPPLIER shall be responsible for the design, manufacture, purchase, quality control, and testing of the fiber optic cable at the point of manufacture, as well as coordinating and executing all freight, transport, and delivery of the fiber optic cable to the designated on-site drop-off location. Additionally, the SUPPLIER shall provide all relevant material certifications, bills of lading, and shipping manifests to the Contractor at least ten (10) business days prior to delivery, and must ensure that all transport vehicles are properly equipped to allow for safe unloading operations by Contractor's personnel.

The CONTRACTOR shall be responsible for all the site infrastructure including all site, civil, structural, electrical, communications elements and installation on site including final site testing.

The references will be used within this specification to define the applicable scope of work and responsible party, Sections not identified as CONTRACTOR or SUPPLIER shall apply equally to both parties.

## PART 1 - GENERAL

### 1.1 DESCRIPTION OF WORK

**A.** This specification specifies the requirements for all strand single mode low-smoke zero halogen fiber optic cable and associated equipment (i.e. connectors and patch panels) to be deployed in an IP Ethernet based network that shall be capable of supporting OC-192 (10 Gbps).

**B.** The cable shall have a dielectric rodent-resistant fiberglass armor, rodent-resistant outer jacket, an interlocking aluminum armor, or a corrugated steel armor. The type of cable used on MBTA property will require approval from the MBTA Communications Department before any installation can take place.

**C.** The cable shall meet the requirements of the National Electrical Code (NEC) Section 770.

**D.** Industrial Ruggedness tested – Applicable Tests: UL 13; UL 444; UL 1277; CSA C22.2 No. 230 and No. 232. The cables shall be Tray Rated.

**E.** Low-Smoke Zero-Halogen – Applicable Flame-Smoke Test: UL 1685, Vertical Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical Fiber Cable. Cable shall be listed OFN-LS. Interlocking armored cables shall be listed OFC-LS. Corrugated armored cables shall be listed OFCR-LS and shall meet ANSI/UL 1666, Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in Shafts.

**F.** Finished cables (SUPPLIER) shall conform to the applicable performance requirements of the Insulated Cable Engineers Association, Inc. (ICEA) Standard for Indoor Outdoor Optical Fiber Cable (ICEA S-104-696).

**G.** Finished cables (SUPPLIER) shall conform to the applicable performance requirements of the Institute of Electrical and Electronic Engineers (IEEE) Vertical Wire Flame Test (IEEE-383).

**H.** At the MBTA's request, the manufacturer(s) (SUPPLIER) shall provide engineering services, installation procedures, and technical support concerning the items contained in this specification.

## 1.2 REFERENCES

**A.** Insulated Cable Engineers Association (ICEA)

**B.** Rural Utility Service (RUS)

**C.** National Electrical Code (NEC)

**D.** Electronic Industries Association (EIA)

**E.** Telephone Industries Association (TIA)

**F.** Institute of Electrical and Electronics Engineers (IEEE)

**G.** Telcordia (formally BellCORE)

**H.** International Telecommunications Union (ITU)

**I.** Underwriters Laboratory (UL)

## 1.3 SUBMITTALS

**A.** Submit descriptive literature and manufacturer specification sheets (SUPPLIER) for all fiber optic cables and equipment proposed for use in accordance with the requirements of specification for approval prior to procurement, fabrication, assembly, installation, and testing.

**B.** Hold Point: Prior to delivering any equipment, submit (SUPPLIER) to the MBTA Communications Department for approval six (6) copies of a detailed test procedure intended to ensure all components of the system are compatible and functioning properly, in accordance with these Specifications. The tests performed shall include, but not be limited to, the tests outlined in this specification. The detailed test procedure shall include a description of all test equipment to be used, and specific pass/fail criteria for each test.

## 1.4 DELIVERY, STORAGE, AND HANDLING

**A.** The SUPPLIER is responsible for handling and delivery of all materials provided under this specification. The CONTRACTOR is responsible for the storage, and handling of all materials provided under this specification after they have been delivered and accepted at the site. Items shall be stored (CONTRACTOR) in a safe and secure location. All equipment shall be protected from water, dust, etc.

**B.** The required length of cable shall be wound on reels. Each reel shall contain only one continuous length of cable. The packaging shall be constructed to prevent damage to the cable during shipping and handling (SUPPLIER).

**C.** When the length of an order requires a large (4 feet or greater) reel, the cable shall be covered with a three layer laminated protective material. The outer end of the cable shall be securely fastened to the reel head 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 (SUPPLIER).

**D.** Test tails shall be at least 2 meters long. The inner end shall be fastened to prevent the cable from becoming loose during shipping and installation.

**E.** Reel Marking and Labeling: Every cable shall be delivered with the following information (SUPPLIER):

1. Reel Label:
    a. Part number
    b. Reel number Length(ft/m)
    c. Marking (ft/m) top and bottom
    d. Date of Manufacture
    e. UL/ETL/CSA listing information
2. Bar Code Label:
    a. Package ID
    b. Reel Number
    c. Quantity Customer ID Package count

d. Factory order number

e. Release part number

f. Length (ft)

g. “Ship to:” Address

h. “Attention to:”

3. Stenciling:

a. Manufacturer’s name and address Direction of rotation

b. Reel Size

c. “DO NOT LAY REEL ON SIDE”

## 1.5 QUALITY ASSURANCE (SUPPLIER)

**A.** The cable manufacturer shall be ISO 9001 registered. Fiber optic cables shall be manufactured in accordance with TL 9000 R3.0.

**B.** All optical fibers in cable lengths of 300m or greater shall be 100% attenuation tested. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers. The manufacturer shall store these values for a minimum of 5 years. These values shall be available upon request.

**C.** Submit under provisions of Submittal Section 2.3.

## 1.6 WARRANTY

**A.** The SUPPLIER/manufacturer(s) shall provide a two-years warranty on parts commencing on the day that the items are accepted by the MBTA and extended warranty for 2 years after testing and commissioning.

# PART 2 - PRODUCTS

## 2.1 MATERIAL

**A.** All material shall be new and unused and the workmanship shall be in accordance with the highest standards of the electronic equipment industry. Provide (SUPPLIER) only new and current material. Material discontinued by the manufacturer shall not be accepted. All components shall be UL listed.

**B.** Material purchased under this Section (SUPPLIER) shall be covered by standards illustrated in paragraph 1.2 and as specified herein.

**C.** Provide all material capable of operating within a transit system environment, subject to temperature, humidity, vibration, and light conditions typically encountered (SUPPLIER).

## 2.2 FIBER OPTIC STRANDS (SINGLE MODE DISPERSION UN-SHIFTED) (SUPPLIER)

**A.** All fibers in the cable shall be usable and meet required specifications.

**B.** Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

**C.** Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design, manufactured utilizing Outside Vapor Deposition.

**D.** Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 $GN/m^2$).

**E.** The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

**F.** The attenuation specification shall be a maximum value for each cabled fiber at 23 ± 5°C on the original shipping reel.

**G.** The single-mode fiber utilized in the optical fiber cable shall meet EIA/TIA-492CAAA, "Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers", ITU recommendation G.652, “Characteristics of Single-Mode Optical Fiber Cable”, ITU recommendation G.957 “Optical Interfaces for Equipment and Systems Relating to Synchronous Digital Hierarchy” and Telcordia “GR-20-CORE”.

1. Cladding Diameter: 125.0 ± 0.7 µm
2. Core-to-Cladding Concentricity: ≤ 0.5 µm
3. Cladding Non-Circularity: ≤ 0.7 %
    a. Defined as:

$$\left(1 - \frac{Minimum\ Cladding\ Diameter}{Maximum\ Cladding\ Diameter}\right) x100$$

4. Mode Field Diameter:
    a. 9.2 ± 0.4 µm at 1310 nm
    b. 10.4 ± 0.5 µm at 1550 nm
5. Coating Diameter: 245 ± 5 µm
6. Attenuation: ≤ 0.4 dB/km at 1310 nm and ≤ 0.3 dB/km at 1550 nm.

7. Attenuation Uniformity: No point discontinuity greater than 0.05 dB at either 1310 nm or 1550 nm.

8. Attenuation at the Water Peak: ≤ 0.4 dB/km at 1383 ± 3 nm.

9. Cutoff Wavelength ( $\lambda_{ccf}$ ): < 1260 nm.

10. IEEE 802.3ae Performance: The fiber shall support laser-based 10 Gigabit Ethernet (GbE) operation in the 10GBASE-LR (1300 nm) up to 10,000 meters.

11. Macrobend Attenuation: The attenuation due to 1 turn of fiber around a 32 mm diameter mandrel shall not exceed 0.03 dB at 1550 nm. The attenuation due to 100 turns of fiber around a 50 mm diameter mandrel shall not exceed 0.03 dB at 1310 nm and 0.10 dB at 1550 nm.

12. Zero Dispersion Wavelength ($\lambda_o$): 1304 nm ≤ $\lambda_o$ ≤ 1324 nm

13. Zero Dispersion Slope ($S_o$): ≤ 0.092 ps/(nm²·km)

14. Dispersion:

    a. ≤ 18 ps/ (nm·km) at 1550 nm.

    b. ≤ 22 ps/ (nm·km) at 1625 nm.

15. Fiber Curl: ≥ 4.0 m radius of curvature

16. Cabled Fiber Polarization Mode Dispersion (PMD): ≤ 0.06 ps $/\sqrt{km}$

## 2.3 CABLE CONSTRUCTION (SUPPLIER)

**A.** Optical fibers shall be placed inside a loose buffer tube. The buffer tubes shall be made of polypropylene. The nominal outer diameter of the buffer tube shall be 2.5 mm.

**B.** For the 96 SM Fiber Optic cable: Each buffer tube shall contain up to 96 fibers.

**C.** For the 12 SM Fiber Optic cable: Each buffer tube shall contain up to 12 fibers.

**D.** The fibers shall not adhere to the inside of the buffer tube.

**E.** Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA- 598-B, "Optical Fiber Cable Color Coding."

**F.** The fibers shall be colored with ultraviolet (UV) curable inks. The UV curable ink shall be applied to the outside of the optical fiber protective coating layer and not be an integral component of the coating layer itself in order to produce more distinguishable colored fiber.

**G.** Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-C, "Optical Fiber Cable Color Coding." Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

**H.** For dual layer buffer tube construction cables, standard colors are used for tubes 1 through 12 and stripes are used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.

**I.** 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 or into the gel filling material. Colors shall not cause fibers to stick together.

**J.** The buffer tubes shall be resistant to kinking.

**K.** Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any filler shall be placed in the inner layer. Fillers shall be nominally 2.5 mm in outer diameter.

**L.** The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to prevent buckling of the cable. The GRP rod shall be overcoated with a thermoplastic, when required, to achieve dimensional sizing to accommodate buffer tubes/fillers.

**M.** Each buffer tube shall contain a water blocking element for water blocking protection. The water swellable element shall be non-nutritive to fungus, electrically non-conductive, and homogenous. They shall be free from dirt and foreign matter. The element shall preclude the need for other water blocking material; the buffer tubes shall be gel-free.

**N.** Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation stranding process. Water blocking yarn(s) shall be applied longitudinally along the central member during stranding.

**O.** Two polyester yarn binders shall be applied contra-helically and with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.

**P.** For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The tape shall be held in place by a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus and electrically non-conductive. It shall also be free from dirt and foreign matters.

**Q.** For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two-layer core. A water blocking tape shall be applied longitudinally over both the inner and outer layer with each being held in place with a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus and electrically non-conductive. It shall also be free from dirt and foreign matters.

**R.** Non-armored cables shall contain at least one ripcord under the sheath for easy sheath removal. Armored cables shall contain at least one ripcord under the steel armor for easy sheath removal.

**S.** Flame-retardant tape may be applied to provide resistance to flame propagation.

**T.** A water blocking tape shall be applied longitudinally around the outside of the flame-retardant tape.

**U.** The tensile strength shall be provided by the central member, and additional dielectric yarns as required. The dielectric yarns shall be helically stranded evenly around the cable core.

**V.** Cables shall be sheathed with a flame-retardant low-smoke zero halogen jacket. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The flame retardant low-smoke zero halogen outer jacket shall contain carbon black, or a UV stabilized colored compound to provide ultraviolet light protection and shall not promote the growth of fungus.

**W.** The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.

**X.** Cable jackets shall be orange, marked with the manufacturer's name or file number, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code (NESC), fiber count, and fiber type, flame rating and listing marking. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

**Y.** The maximum pulling tension shall be 2700 N (600 lbf) during installation (short term) and 810 N (180 lbf) long term installed.

**Z.** The non-armored cable shall be all-dielectric.

**AA.** Un-armored, double-dieletric cables shall be listed OFN-LS and shall be as described previously through paragraph 2.3-Q. The maximum pulling tension shall be 4500 N (1000 lbf) during installation (short term) and 1500 N (333 lbf) long term installed.

**BB.** Interlocking armored cables shall be as described previously in this section but shall also include an interlocking aluminum armor applied helically around the outside of the fiber optic cable. The interlocking armor may be left un-jacketed or may have a flame-retardant low-smoke zero halogen outer jacket. The armor for these cables shall be comparable to liquid tight flexible metal conduit if jacketed, or flexible metal conduit if not jacketed. Because of the interlocking metallic armor, this cable shall be listed OFC-LS. The interlocking armor and outer jacket options will be specified on the purchase order. Cables with interlocking armor shall be available in fiber counts up to 288 fibers.

**CC.** Corrugated armored cables shall have an armor layer applied directly over at least one ripcord and a water blocking tape that shall be applied longitudinally around the cable. The tape shall be held in place by a single polyester binder yarn. The armor shall be corrugated steel tape, plastic-coated on both sides for corrosion resistance, with an overlapping seam with the corrugations in register. A water swellable Mylar tape shall then be placed around the corrugated steel tape. The outer flame-retardant low-smoke zero halogen jacket shall be applied over the water swellable Mylar tape. Because of the corrugated metallic armor, this cable shall be listed OFCR-LS. Any outer jacket options shall be specified on the purchase order. Cables with corrugated armor shall be available in fiber counts up to 288 fibers.

## 2.4 CABLE SPECIFICATION (SUPPLIER)

**A.** Temperature Range: The storage temperature range for the cable on the original shipping reel shall be -30 °C to +70 °C. The installation temperature range for the cable shall be -5 °C to + 50 °C. The operating temperature range for the cable shall be -30 °C to + 70 °C. Testing shall be in accordance with FOTP-3.

**B.** Tensile Loading and Fiber Strain: When tested in accordance with FOTP-33, the “Fiber Optic Cable Tensile Loading and Bending Test,” and FOTP-38, “Measurement of Fiber Strain in Cables Under Tensile Load,” a length of cable shall be tested to the rated tensile load. The rated tensile load shall be 2670 N (600 lbf). While under the rated tensile load, the fiber shall not experience a measured fiber strain greater than 60% of the fiber proof test level. After being held at the residual load (30% of the rated tensile load) the fiber shall not experience a measured fiber strain greater than 20% of the fiber proof test level nor an attenuation change greater than 0.40 dB at 1550 nm (single-mode). After the tensile load is removed, the fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode).

**C.** Compressive Loading Test: When tested in accordance with FOTP-41, “Compressive Loading Resistance of Fiber Optic Cables,” the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in). Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5 mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.4 dB at 1550 nm for single-mode fibers.

**D.** Cyclic Flexing: When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The flexing arc shall be +90 degrees from the reference position. The fiber shall not experience an attenuation change greater than 0.4 dB at 1550 nm (single-mode). No cracks, splits, tears or other opening shall be present on the inner or outer surface of the jacket. No visible cracks greater than 5mm in the armor, if present, shall be present.

**E.** Twist Test: When tested in accordance with FOTP-85, “Fiber Optic Cable Twist Test,” a length of cable no greater than 2 meters will withstand 10 cycles of mechanical twisting. The fiber shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode).

**F.** High and Low Temperature Bend: When tested in accordance with FOTP-37, "Fiber Optic Cable Bend Test, Low and High Temperature," the cable shall withstand four full turns around a mandrel at test temperatures of -10 °C and +60 °C. The mandrel diameter shall be the larger of 20X cable diameter or 150 mm for general purpose and riser cables. The presence of visible cracks, splits, tears, or other openings on either the inner or outer surface of the jacket constitutes failure. None of the sheath components shall show visible cracking when removed successively and examined. For single-mode fibers, the increase in attenuation shall be < 0.40 dB at 1550 nm.

**G.** Impact Resistance: When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand a minimum of 2 impact cycles at 3 locations spaced 150mm. The impact energy shall be at least 4.4 N·m. The fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode). The presence of visible cracks, splits, tears, or other openings on the outer surface of the jacket constitute a failure. The presence of broken fibers within the specimen constitutes a failure.

**H.** Temperature Cycling: When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation after 2 cycles at extreme operational temperatures (-40 °C to +70 °C) shall not exceed 0.4 dB/km at 1550 nm (single-mode). The change in attenuation is measured with respect to the baseline values measured at room temperature before temperature cycling and after the last low and last high temperature.

**I.** Water Penetration: When tested in accordance with FOTP-82, “Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable”, a one-meter length of unaged cable shall withstand a one-meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.

**J.** Cold Impact Test: When tested in accordance with FOTP-25, “Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies,” the cable shall withstand a minimum of 2 impact cycles at 3 locations separated by 150 mm. The impact energy shall be at least 2.94 N·m. The cable shall be conditioned for at least 4 hours at the minimum installation temperature (-10 °C). The presence of visible cracks on either the inner or outer surface of the jacket constitutes a failure. No optical measurements are required.

## 2.5 EQUIPMENT RACK (CONTRACTOR)

**A.** The equipment rack shall conform to Electronics Industry Association (EIA) EIA-310 standards (refer to specification section 16782 Communications Equipment Racks and Cabinets). The rack shall be 213 cm (7 feet) tall with a 48.3 cm (19 inch) standard panel mounting flange width and shall contain forty-four usable rack spaces. One EIA rack space or panel height (denoted as 1U) is defined as being 44.45 mm (1.75 in.) in height with mounting holes on each upright of the rack. Equipment mounting holes shall be tapped with 10-32 UNF-2B threads. Installation fasteners shall be included.

**B.** The rack shall come equipped with a top jumper trough with radius guides for distributing jumpers between equipment bays.

## 2.6 PATCH PANEL (CONTRACTOR)

**A.** The Patch Panel shall be a rack mountable combination connector and splice housing. The housing shall accommodate pigtail splicing via splice trays with pigtailed connector panels. The unit shall be sized to accommodate a 12, 96, or 144 strand fiber optic cables (ST bulkhead ports).

**B.** Housings shall be mountable in an EIA-310 compatible 19-inch or 23 inch rack. Housings shall be between 1 to 4 rack unit size. One EIA rack space or panel height (denoted as 1U) is defined as being 44.45 mm (1.75 in.) in height.

**C.** The unit shall be mounted with a 13 cm frontal projection, with the option to flush mount with separately purchased brackets.

**D.** The unit shall not exceed a depth requirement of 42 cm.

**E.** The unit shall meet the design requirements of ANSI/TIA/EIA-568 and the plastics flammability requirements of UL 94 V-0.

**F.** Housings shall be manufactured using 16-gauge aluminum or equivalent for structural integrity and shall be finished with a wrinkled powder coat for durability. Assembly hardware and equipment attaching machine screws shall be included and shall be similar in color.

**G.** The front of the housing shall contain jumper egress openings on both sides that are aligned with the jumper routing guides, and will provide access for optical fiber jumpers and patch-cords as they enter or exit the front sides of the housing.

**H.** The housing shall accommodate pigtail splicing via interchangeable splice Cassettes with pigtailed connector panels, while maintaining the capability to accommodate pigtailed connector modules and/or pigtailed connector panels outside of the splice cassettes.

**I.** The housing shall provide means for strain-relieving fiber optic cables both interior to and exterior to the rear of the housing. External strain-relief shall be achieved through attachment of an external strain-relief bracket that attaches onto either side of the housing via two fasteners. The external strain-relief bracket shall provide slots or holes for securing cables with cable ties (“ty-wraps”) and/or hook-and-loop type straps. The external strain-relief bracket shall provide threaded holes for attaching up to two cable clamps, sold separately. The cable clamp shall accept one cable from 9.5 to 28.6 mm in diameter. The cable clamp mechanism shall also handle multiple smaller fiber count cables when used with a multiple cable insert. The total cable capacity per clamp shall be five cables (≤ 10.2 mm OD) when used with a multiple cable insert. Housing cable clamp capacity shall be four clamps. Internal strain-relief shall be achieved through on of three means: 1) attachment of a removable and interchangeable internal strain-relief bracket that mounts on the floor of the rear assembly housing via retention studs and a spring loaded plunger, 2) strain-relieving directly to the inside surface of the door, or 3) strain-relieving slots

on both sides of the rear corners of the tray for securing cables via cable-ties or hook-and-loop type straps for when cable(s) enter directly through and perpendicular to the rear door. The internal strain-relief bracket shall strain-relieve a single cable up to 34.0 mm or multiple cables of a comparable bundle diameter. The internal strain-relief bracket shall incorporate pairs of lances for cable-ties, straps, or hook-and-loop type tape.

**J.** Front and rear doors of the housings shall be hinged and removable for ease of cable installation. The front door shall contain two slam latches (located on the left and right side of the door) that can individually be de-latched with single-hand operation and the rear door shall contain a turn-latch in the center of the door for opening and closing the door. The front and rear doors shall be lockable when used with an optional key lock kit. Jumpers shall route out the sides of the patch field.

**K.** The housings shall have a labeling scheme that complies with ANSI/TIA/EIA-606.

**L.** The housing shall contain a transitional strain-relief clip which shall be capable of holding six (6) buffer tube transition kits that can each manage a single twelve-fiber buffer tubes and a ninety six buffer tubes. Fiber fan-out devices are used to build 250 µm fiber in buffer tubes out to 900 µm for fiber protection and to allow connectorization.

## 2.7 FIBER OPTIC PIGTAILED PANELS/PIGTAILED MODULES (CONTRACTOR)

**A.** Fiber optic pigtailed panels shall be comprised of six or twelve single-mode fiber strands compliant with TIA/EIA-568-C-3. The pigtails shall have factory installed ST-Compatible connectors. These ST-Compatible connectors shall be connected to an adapter panel with 12 ST-Compatible adapters. The pigtails shall be a minimum of 3 meters in length.

**B.** Fiber optic pigtailed modules shall be removable modules that hold one adapter panel, one pivoting splice tray, twelve heat shrinks and up to twelve individual pigtails. The pigtails shall be as described in section 3.7 above.

**C.** The pigtails shall have an insertion loss of 0.5 dB maximum and a minimum reflectance of - 55 dB.

# PART 3 - EXECUTION

## 3.1 PRIOR TO INSTALLATION

**A.** Prior to site acceptance, the CONTRACTOR shall verify conduits, inner ducts, and general site conditions are suitable for the installation of cables and equipment.

**B.** The CONTRACTOR shall submit, to the MBTA,

1. Construction Work Plan (CWP) 30-days prior to start of installation and shall attend site Construction Coordination Meetings at least 4-weeks prior to beginning installation. Construction Work Plan shall include but not be limited to:

    a. Site Location – description and diagram of installation area.

    b. Contact – Company name of installer, name, and contact information (cell phone) of site supervisor.

    c. List of Materials and Equipment to be installed and used to install.

    d. Name and contact info of all other Contractor's working in or around area.

    e. Set up or pull locations -- selected to protect the cable on the reel and in slack loops. The Contractor shall be responsible for protecting cable after working hours

    f. For cable installation not completed during a single installation task, cables damaged due to Contractor's neglect while installing cable shall be replaced by the Contractor at no additional cost to MBTA.

    g. Pull Calculations

    h. Bend Radius shall be shown to not exceed manufacturer recommendation both during the pull and when at rest.

    i. Pull/blowing lengths -- shall be designed to not exceed 80% of the rated cable tensile strength or 600 lbs during installation whichever is less. No residual tension shall remain on the cable after installation except that due to the cable's weight in the vertical rise. Assist points for blowing cable shall be identified.

    j. If a winch or pulling machine is used during installation, a dynamometer shall be

    used to monitor the tension on the cable. The dynamometer shall be certified as calibrated and shall hold the peak value of the cable pull. The peak value shall be recorded and forwarded to the MBTA as part of the installation test data submittals.

    k. The maximum vertical rise shall be defined as the distance over which the cable is self-supporting. Cable strain relief shall be used at the top of each vertical rise and no less than every time that 80% of vertical rise rating of the cable is exceeded.

    l. Cable shall not be twisted. Care shall be exercised to roll cable off the spool and to not spin it off the spool.

## 3.2 INSTALLATION (CONTRACTOR)

**A.** The Contractor shall submit the following information in the Construction Work Plan for each segment of cable to be installed:

1. Cable pulling layout including distances, bends, and tension calculations for each section of the installation

2. Calibration records for all pulling equipment and tension monitoring devices shall be submitted.

3. Chronological plan for installing cable, including estimated time for each pull and plan for protecting cable on reel, in slack loops during installation, and after the pull has been completed.

**B.** The Contractor shall provide the MBTA a minimum of 48 hours' notice prior to installing cables.

**C.** Installation Methods – at all times the Contractor shall use the least damaging installation method to install cables in order to ensure maximum cable life and maintainability. Methods of installation shall include:

1. Use of innerduct – the Contractor shall use innerduct within ducts, conduits, and cable trays to optimize conduit usage and prevent damage to cable both in current installation and in future installations. Pneumatic couplers shall be used to take advantage of cable blowing installation methods.

2. Intermediate manholes and handholes – Fiber cables passing through intermediate manholes and handholes shall be racked and use continuous innerduct.

3. Cable Blowing – the preferred method of installing fiber cable in ducts with PVC innerduct shall be blowing.

4. Cable Pulling - the preferred method of installing fiber cable in ducts with textile innerduct shall be with a pull rope.

5. Cable Laying – in cable trough the Contractor shall use cable laying techniques to reduce stress. Cables shall not be pulled through cable trays.

6. Cable Pulling – Due to the potential for stress damage the Contractor shall continuously monitor stress placed upon the cable with dynamometer or approved equivalent test equipment. The maximum pull tension for the cable shall not be exceeded. The maximum recommended load value for long term application shall not be exceeded after the cable has been placed. Dynamometer or approved equivalent test equipment calibration records and data from the monitoring shall be submitted with the cable test results.

7. Slack Cable – every cable length greater than 1000 feet shall have one (1) 60-foot slack coil of cable placed at either end. A minimum of one (1) 30-foot slack coil shall be placed at either end of every fiber cable.

8. Slack Enclosure- Fiber Optic Slack loops shall be placed outside the rack/cabinet on a NEMA 4X slack storage enclosure that can accommodate up to 100ft of FO cable. Enclosures shall be wall or pole mounted and shall include document pocket, and lockable "L" pad lock handle (or hasp and stable with lever type, quick release fastener around door perimeter). Door stiffeners shall be provided as required.

9. Bend Radius – fiber cable shall not be bent to a smaller radius than its minimum installation radius value. After pulling tension is removed, cable may be bent to a radius no smaller than the long-term application bend radius for the cable.

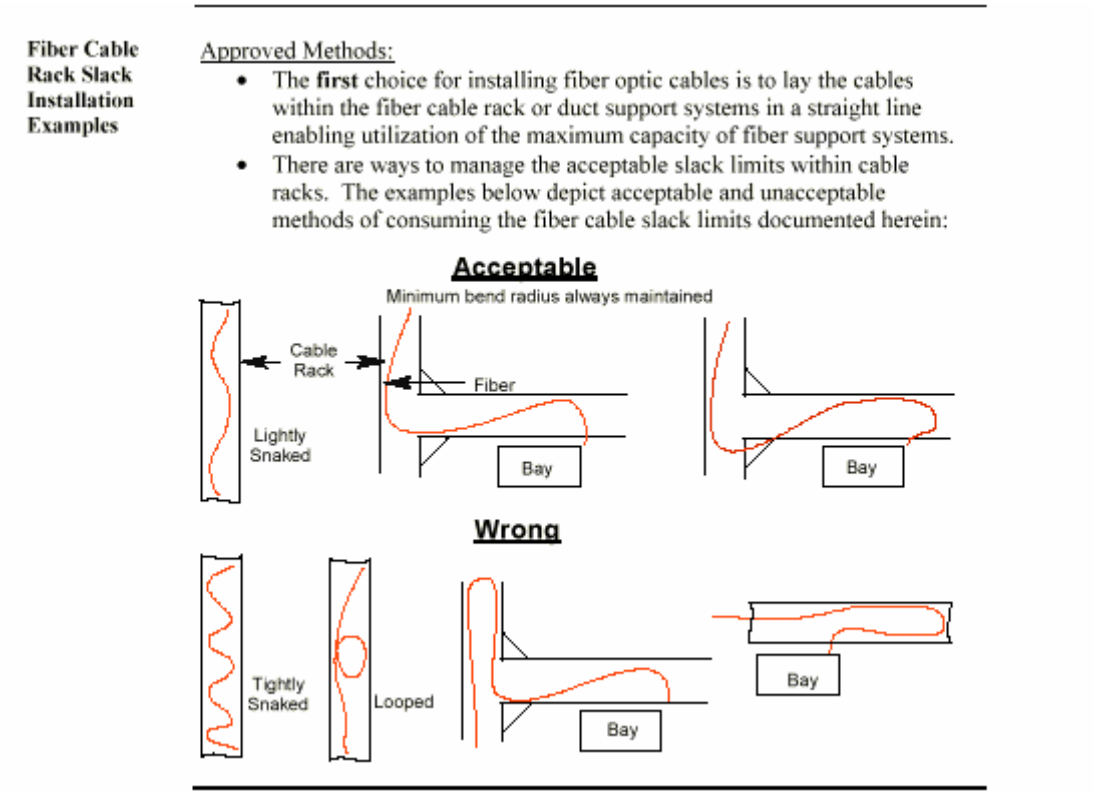



**Figure 1**

a. Plastic cable ties shall not be used for banding or securing fiber optic cables/patch cords. Hook and loop cable ties shall be used for banding or securing fiber optic cables and patch cords.

b. All fiber optic cabling in racks or cable trays shall be secured using hook and loop cable wraps.

c. All 90-degree corners used to route and support fiber cables on cable racks shall be equipped with corner brackets to maintain a greater than minimum bend radius.

10. Damage Protection

a. Where cables leave conduits, the ends of the conduit shall be fitted with end bells to prevent damage to the cable.

b. In other installations where sharp edges are encountered, the Contractor shall supply protection from friction damage.

c. In manholes, where splices or slack is present, slack, and/or splice case shall be secured to wall of manhole on an approved cable racking device.

11. Penetrations -- All cable entrance openings shall be sealed with either a compression type fitting or pliable sealing compound after the cable is in place. Sealing compound shall be used to seal the area around cable where the cable emerges from the end of a conduit or pipe. Sealing compounds for rooms, houses, walls, or other partitions shall be fire retardant per ASTM E-814. All spare conduits shall be sealed or plugged in an approved manner. Cable openings within the substation floors and/or walls shall be sealed with an approved fire sealant.

12. The Contractor shall provide service loops sufficient for the maintenance and free movement of attached electrical equipment.

13. Fiber optic cables shall not be combined with copper wire and cable in cable trays or conduits.

**D.** Cable Identification

1. All cables shall be tagged at their termination points. In addition, all exposed cables shall be tagged within Communications Rooms, manholes, handholes, housings, and ancillary equipment and on each side of any barrier the cable passes through. Cables shall also be tagged at aerial exits from conduit risers.

2. Identification Tags shall comply with IFB Document – Documentation, Asset, Cable, and Software Management.

**E.** Fiber Terminations

1. All fibers shall be terminated. Fibers shall be factory connectorized and terminated with factory polished pig-tails fusion spliced to the backbone cable. For all fiber, an ultra-polish (UPC) connection shall be used. Splices of backbone fibers to pigtails shall be made in Fiber Distribution Panels secured within Communications Hut/Rooms, or Communication outdoor SES Cabinets.

    a. Pigtail Connectors shall be Telcordia 326 compliant ’ST’ type, unless otherwise noted, meeting the following performance requirements:

        1). Insertion Loss less than 0.20 dB

        2). Single Mode Return Loss greater than -55.0 dB

        3). Fiber type and specifications shall match those fibers contained in fiber cable that is being terminated.

    b. Manufacturer shall have an in-depth knowledge and more than ten years’ experience in the manufacturing of and supporting connector technology that does not require epoxy or polishing in the field.

**F.** Fiber Splicing

1. Fiber Optic splicing work shall be performed by the MBTA only. Contractor is responsible for the fiber optic cable installation. Contractor shall coordinate with the MBTA Fiber department once the fiber optic cable is installed and ready to be spliced.

2. Fibers shall be fusion spliced only (no mechanical splices) with the following performance requirements:

    a. Attenuation Due to Splice shall not exceed 0.3dB @ 850, 1300, 1310, and/or 1550 nm per EIA/TIA 568.

    b. Attenuation to be measured by determining the average of a two-way OTDR test (see ANSI/TIA/EIA-455-8-2000). Unidirectional measurement of greater than 0.3dB shall result in a remake of the splice.

3. Regardless of splice loss attenuation, splicing of two dissimilar fibers shall not be permitted. For example: the Contractor shall not splice single mode and multi-mode fiber together.

4. Individual splices shall be protected by a reinforced heat shrink sleeve.

5. Heat shrink sleeves shall be affixed to splice tray with appropriate dimensions for fiber loops as required.

6. Splice trays shall be firmly mounted into an outdoor rated splice enclosure or into an FDP.

7. The design shall ensure splice remains moisture free for an indefinite period of time.

8. When splice is located in airtight enclosure, water-absorbing material such as desiccant gel shall be added to absorb any potential condensation.

9. Splices shall, without exception, be located within a splice tray, an OSP Fiber Splice Case, or an FDP.

10. OSP Fiber Splice Cases shall be used only where specifically authorized by the MBTA and shall be designed and maintained as re-enterable splices. No gel type encapsulant shall be permitted except as in item 3.2.G.6 above. If required, dry type encapsulant shall be used.

11. Splice Tray

    a. Strip buffer tube as follows:

        1). Standard Length Tray (> 11.0”) – minimum strip length 62”

        2). Reduced Length Tray (≤11.0”) – minimum strip length 50”

    b. Routing

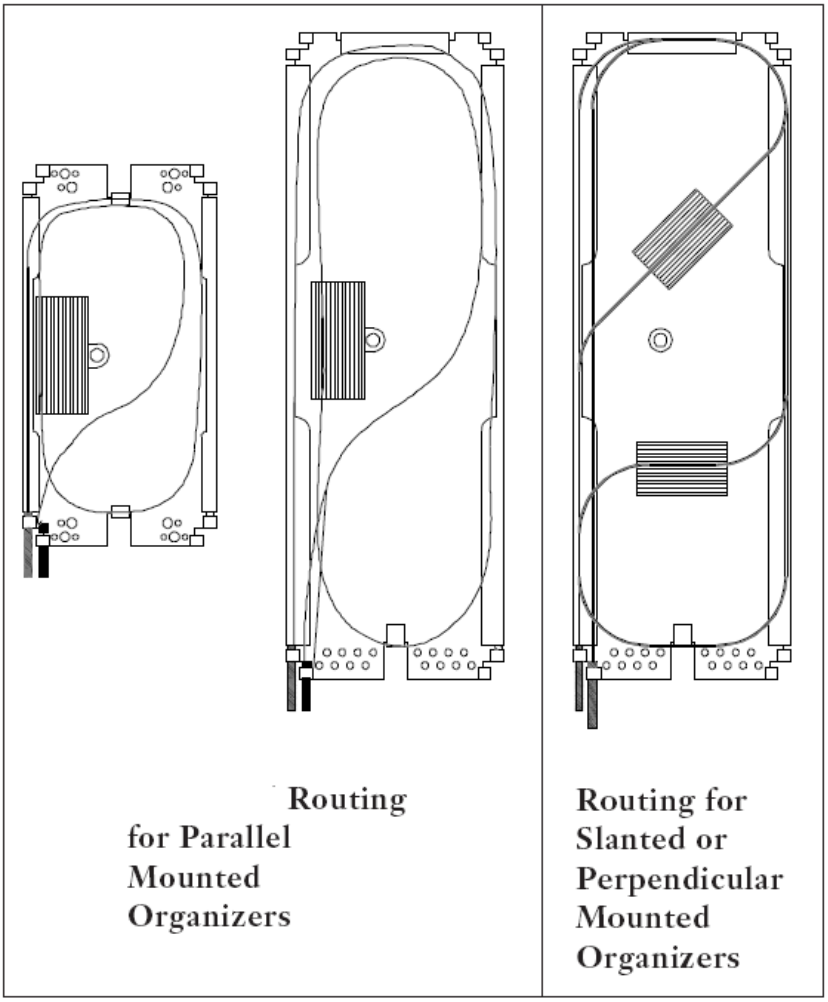



**Figure 2**

c. When the step slot organizer is filled or all fiber pairs are spliced, fill the occupied organizer grooves with RTV silicone compound. Do not overfill. Cut a piece of waxed paper to approximately the size of the step slot organizer and place it on top of the organizer to keep the splice tray cover from becoming glued to the organizer.

## 3.3 FIELD TESTING (CONTRACTOR)

**A.** All tests shall be conformed to the requirements of Section 16899 – SECURITY AND COMMUNICATIONS SYSTEMS TESTING.

**B.** Tests for each fiber (CONTRACTOR)

1. End Face Inspection
2. Channel Map documentation

3. Bi-directional end to end Power meter tests, including splices and terminations, at 1310mm and 1550mm for single mode fiber and at 850mm and 1300mm for multi-mode fiber

4. Three-Lambda Bi-Directional OTDR, Tier 1 and Tier 2 at 1310, 1550, and 1625nm)

5. Polarization Mode Dispersion

6. OLTS Certification

7. 10-Gb/s data speed verification

8. Test Documentation

**C.** All Field Testing shall require the observation and signature of an independent witness accepted by the MBTA.

**D.** All test equipment shall be calibrated annually with calibration traceable to NIST. (CONTRACTOR)

## PART 4 - MEASUREMENT AND PAYMENT

### 4.1 MEASUREMENT

**A.** The cost for all work, complete in place; furnishing [SUPPLIER] all materials, equipment and accessories required; providing transportation, handling and delivery; and performing all work incidental to completion of work of this Section as it pertains to SUPPLIER scope, shall be included in the Contract Unit price items below.

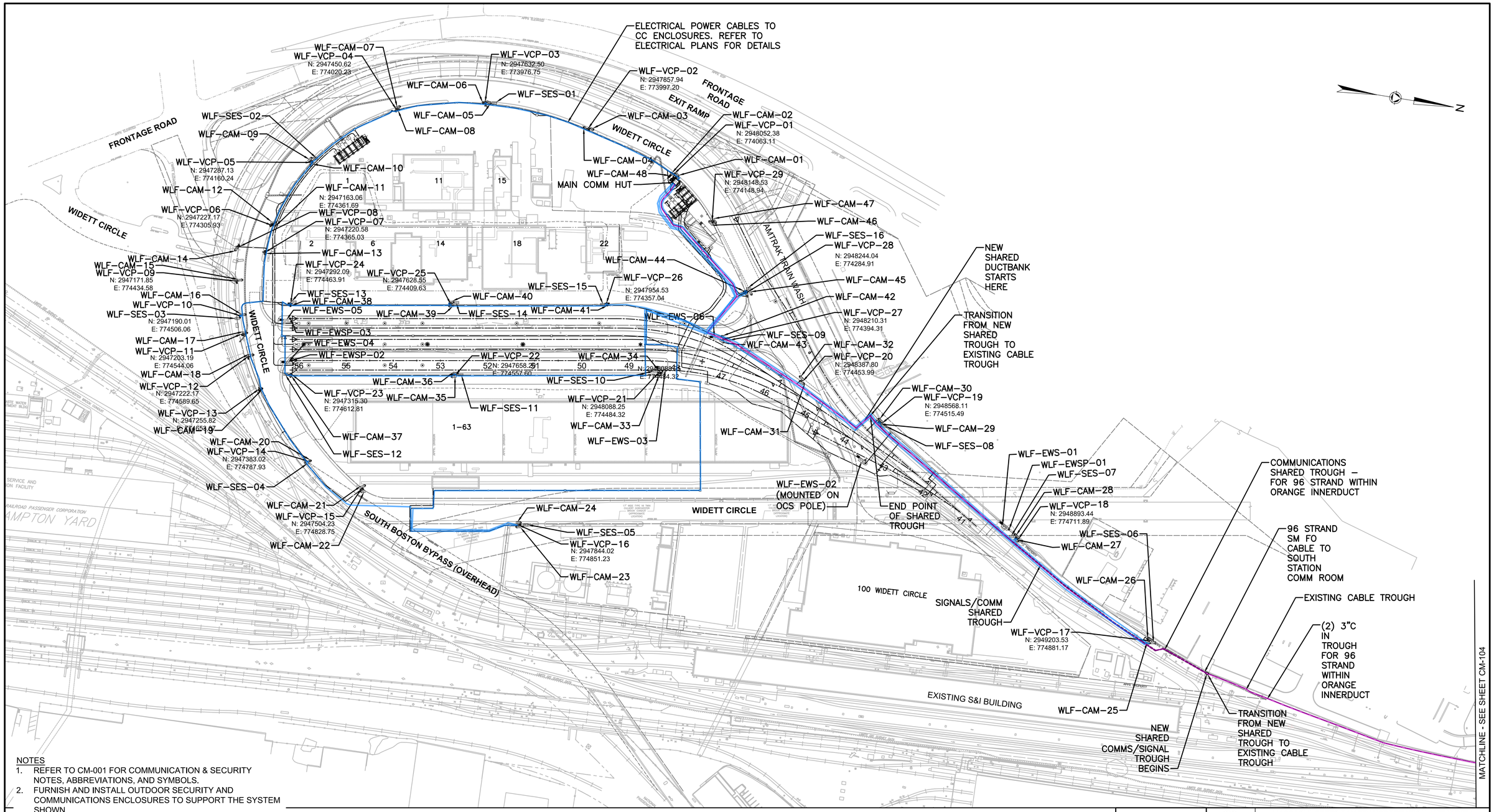
### 4.2 PAYMENT

**A.** All costs in connection with work of this Section as it pertains to the fiber optic cable Supplier scope, shall be included in the total Contract Unit Price for Item 1650.037P– Furnish 12-Strand Outdoor Fiber Optic Cable and 1650.038P- Furnish 96 Strand Outdoor Fiber Optic cable

### 4.3 PAYMENT ITEMS

| ITEM NO. | DESCRIPTION | UNIT |
|---|---|---|
| 1650.037P | FURNISH 12-STRAND OUTDOOR FIBER OPTIC CABLE | LF |
| 1650.038P | FURNISH 96-STRAND OUTDOOR FIBER OPTIC CABLE | LF |

**END OF SECTION**




NOTES

1. REFER TO CM-001 FOR COMMUNICATION & SECURITY NOTES, ABBREVIATIONS, AND SYMBOLS.
2. FURNISH AND INSTALL OUTDOOR SECURITY AND COMMUNICATIONS ENCLOSURES TO SUPPORT THE SYSTEM SHOWN.
3. FURNISH AND INSTALL CABLES AND DUCTBANK AS SHOWN FOR CONNECTIVITY TO EACH CAMERA AND DEVICES.
4. INSTALL NEW EQUIPMENT AT THE LOCATION SHOWN. FIELD VERIFY EXISTING CONDITIONS AND COORDINATE THE FINAL MOUNTING LOCATION TO AVOID CONFLICT INTERFERENCES. MINOR ADJUSTMENTS MAY BE MADE AS REQUIRED TO ACCOMMODATE VERIFIED FIELD CONDITIONS, SUBJECT TO APPROVAL BY THE ENGINEER. MAINTAIN ALL REQUIRED WORKING CLEARANCES, TRACK CLEARANCES, ACCESS, AND SEPARATION IN ACCORDANCE WITH THE NEC AND OTHER APPLICABLE CODES.
5. REFER TO CM-200 FOR CONDUIT ROUTING PLAN AND CM-301 FOR SITE FIBER ROUTING PLAN.
6. REFER TO DWG. E-802 FOR DUCTBANK DETAILS.
7. CONTRACTOR SHALL REUSE EXISTING TROUGH AS SHOWN. IF TROUGH IS DAMAGED, THE CONTRACTOR SHALL REPLACE PER SPECIFICATIONS

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MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

WIDETT LAYOVER FACILITY
DP1 - DEMOLITION & SIX LAYOVER TRACKS
MBTA CONTRACT NO. F60CN01
BOSTON, MASSACHUSETTS

COMMUNICATION AND SECURITY SYSTEMS
OVERALL SITE LAYOUT PLAN


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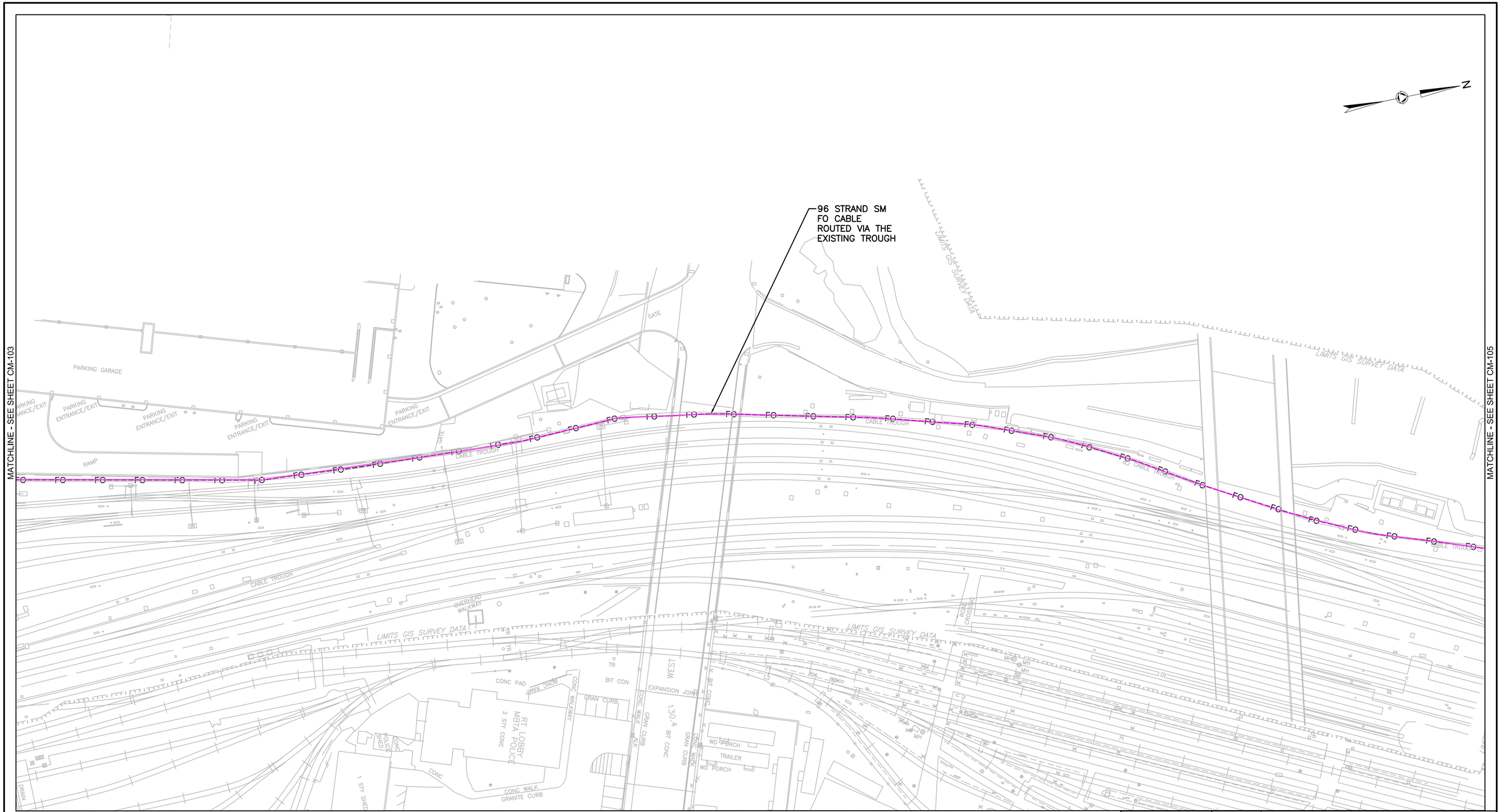
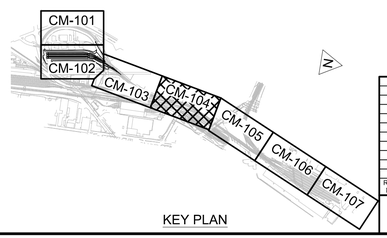



NOTES
1. REFER TO CM-001 FOR COMMUNICATION & SECURITY NOTES, ABBREVIATIONS, AND SYMBOLS.

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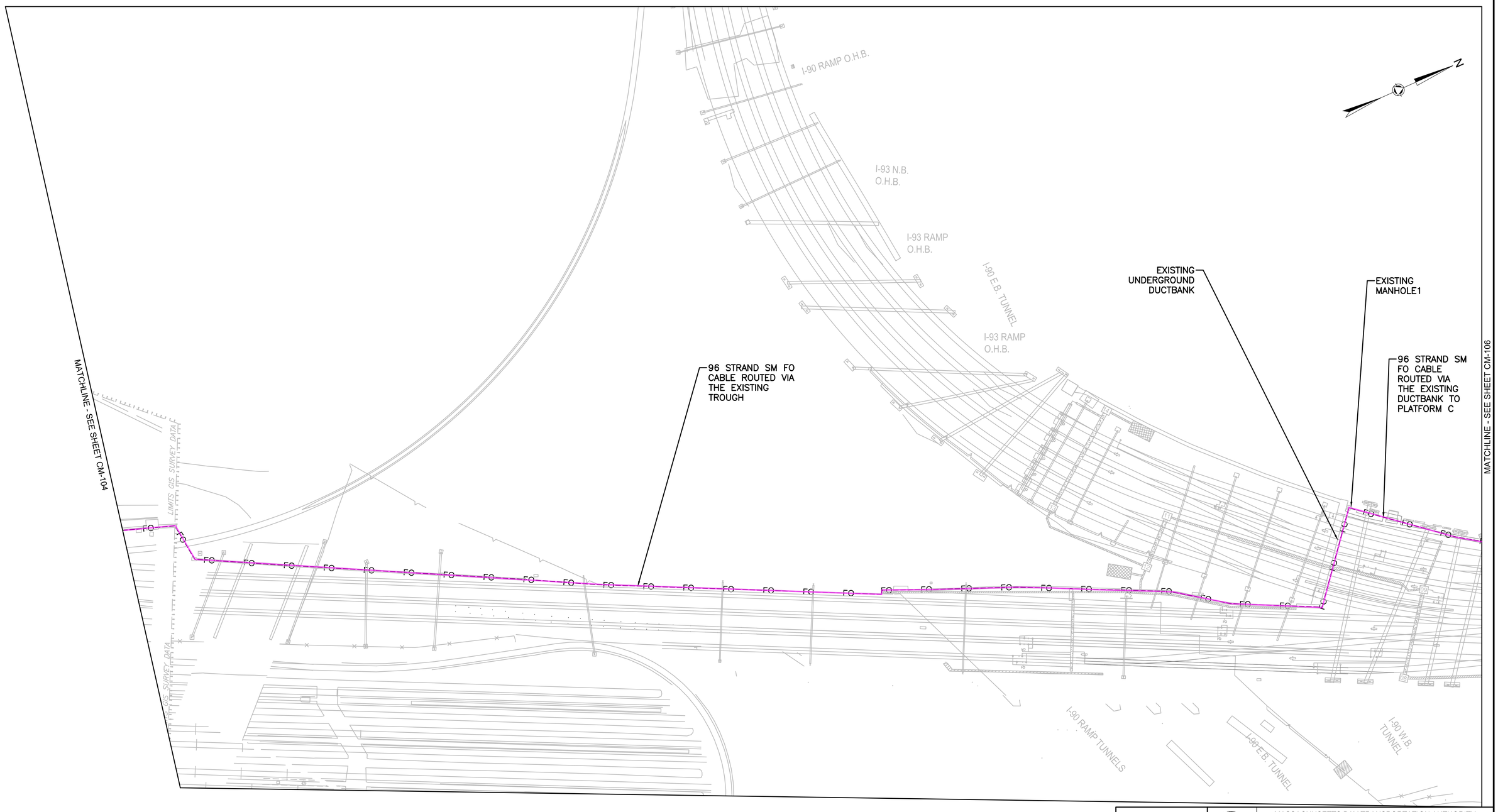
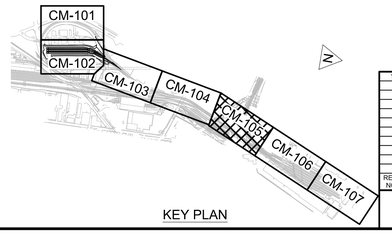



NOTES
1. REFER TO CM-001 FOR COMMUNICATION & SECURITY NOTES, ABBREVIATIONS, AND SYMBOLS.
2. CONTRACTOR SHALL COORDINATE WITH KEOLIS AND AMTRAK DURING THE INSTALLATION OF THE 96 STRAND SM FO CABLE FROM WIDETT CIRCLE LOOP TO SOUTH STATION MBTA COMMUNICATIONS ROOM LOCATED IN THE BASEMENT LEVEL OF THE RED LINE.
3. CONTRACTOR TO VERIFY SPARE CONDUIT CONDITIONS PRIOR TO INSTALLING THE FIBER OPTIC CABLE. IF SPARE CONDUIT IS NOT AVAILABLE TO BE USED OR DAMAGED, CONTRACTOR TO PROVIDE NEW CONDUIT.

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DP1 - DEMOLITION & SIX LAYOVER TRACKS
MBTA CONTRACT NO. F60CN01
BOSTON, MASSACHUSETTS

COMMUNICATION AND SECURITY SYSTEMS PLAN
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Project Manager Date

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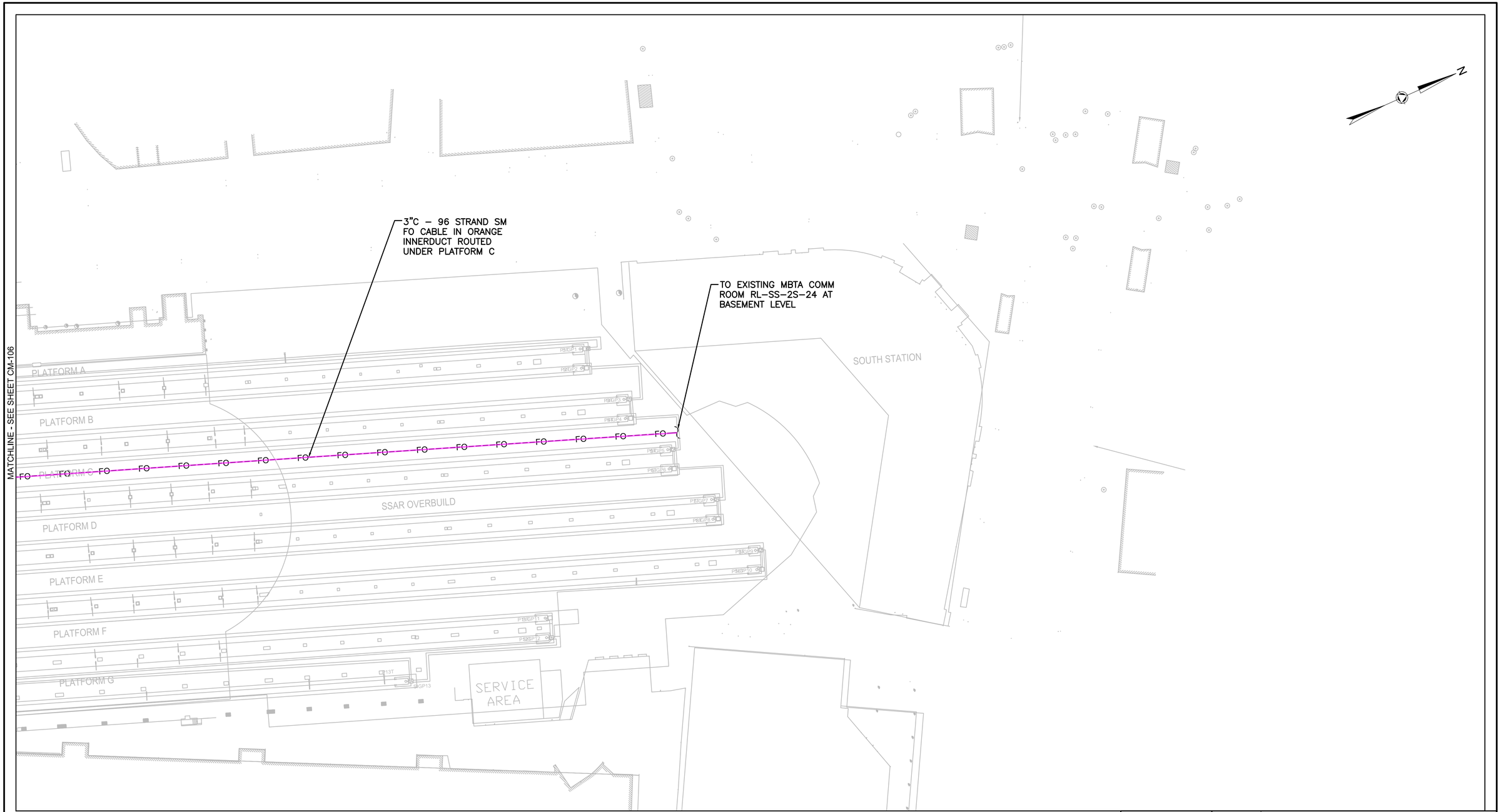
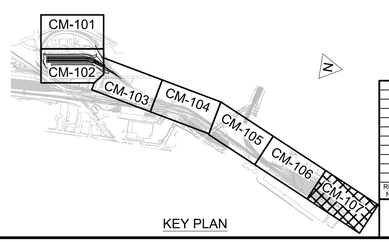



NOTES

1. REFER TO CM-001 FOR COMMUNICATION & SECURITY NOTES, ABBREVIATIONS, AND SYMBOLS.
2. ROUTE NEW FO CABLES FROM PLATFORM C TO THE BASEMENT LEVEL COMMUNICATIONS ROOM RL-SS-2S-24.
3. FURNISH AND INSTALL NEW FOPP AND NEW SWITCH TO SUPPORT THE INTEGRATION TO THE EXISTING NETWORK.

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