### SECTION 680 – FIBER OPTIC CABLE

**DESCRIPTION**

**680.01.01 GENERAL**

***DELETE PARAGRAPH “B” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

B. All equipment and cable selection, mounting, and installation, as well as the cable management plan for Arterial Management System (AMS) and Freeway Management System (FMS) must be approved by the Freeway & Arterial System of Transportation (FAST) Director or designee, prior to installation.

***ADD THE FOLLOWING PARAGRAPH TO THIS SUBSECTION:***

C. All equipment and cable selection, mounting, and installation, as well as the cable management plan for City of Las Vegas (CLV) City Fiber Optic (CFO) system must be approved by the CLV Transportation Engineering Division (TED) or designee, prior to installation.

***ADD THE FOLLOWING SUBSECTION TO THIS SECTION:***

* + 1. **SUBMITTALS**

A. The submittals indicated below shall be provided as specified in Section 105.02, Plans and Working Drawings.

B. The Installer (licensed Contractor or installation subcontractor) shall have experience in the furnishing, installing and testing of single mode fiber optic cable. This experience shall include 5 projects with a project value of more than $25,000 each within the past 5 years.

C. The Contractor shall submit, one day after the bid opening, a list of qualifying experience on the INSTALLER EXPERIENCE FORM, FIBER OPTIC CABLE (See Attachment 5 in the Bid Proposal Pages) [NOTE TO SPEC WRITER – REMEMBER TO SEND ATTACHMENT 5 TO THE CONTRACT SPECIALIST, ATTACHMENT 5 IS INCLUDED IN THE SPECIAL PROVISIONS FOLDER] All required information, including: project name, Date Completed, name of owner, contact person and phone number, project cost and length of the fiber optic cable installed.

D. It is required that the superintendents of the crews installing and testing the Fiber Optic Cable have a minimum of three (3) years fiber optic cable installation supervisory field experience on at least 3 of the successfully completed projects listed on the INSTALLER EXPERIENCE FORM, FIBER OPTIC CABLE.

**MATERIALS/EQUIPMENT**

**680.02.01 FIBER OPTIC OUTSIDE PLANT TRUNK CABLE (TRUNK CABLE)**

***DELETE PARAGRAPH “H” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

H. Conductive Line Locating Material:

1. In AMS and FMS conduits a #10 AWG (American Wire Gauge) THW tracer wire shall be directly adjacent to the cable in every conduit containing fiber optic cables to aid in locating of the conduit once it is in place.
2. Any other method of providing a conductive tracer wire must be approved by the FAST Director, or designee prior to installation.
3. In CFO conduits a #10 AWG THW tracer wire shall be directly adjacent to the cable in every conduit containing fiber optic cables. This #10 AWG THW Tracer Wire shall be installed within all CFO conduits (empty and with cables).
4. Any other method of providing a conductive tracer wire must be approved by the TED or designee prior to installation.

***ADD THE FOLLOWING PARAGRAPH TO THIS SUBSECTION:***

J. Cable Labels:

1. Cable labels shall be made of flame retardant material 5.5 mils in thickness and 1/4 inch minimum width. The labels shall be flexible, resistant to oil and water, and shall have the capability of being moved along the cable during future alterations. The film material shall conform to the flame retardant requirements of UL 510 and be rated at 150 degrees C.
2. Appropriate numbers and letters shall be printed on cable labels for cable function (i.e., CFO, AMS, FMS), direction of the cable (i.e, North, East, etc.) along with its next point of entry identification (i.e., SWC of XYZ St. & ABC Blvd.).

**CONSTRUCTION**

* + 1. **INSTALLATION - GENERAL**

***DELETE PARAGRAPHS “C.1” and “C.2” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

1. Certifications for AMS and FMS installations shall be approved by the FAST Director or designee prior to construction. Certifications for CFO installations shall be approved by TED or designee prior to construction.
2. Fiber optic cable shall be continuous and without splices unless approved by the FAST Director or designee for AMS and FMS installations, and TED or designee for CFO installations, unless noted otherwise on the splice details provided.

***DELETE PARAGRAPH “H.4” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

1. Two weeks prior to disconnecting any existing cables, the Contractor shall submit a schedule, for approval by the FAST Director or designee for AMS and FMS installations, and approved by TED for CFO installations, with the accurate time frames of when the existing cables are to be disconnected.

***DELETE PARAGRAPH “I” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

1. In all locations where fiber enters a pull box, for each cable entering the pull box or vault, cable slack shall be loosely looped through a figure-8 or a loose loop with a minimum of 50 feet of slack in all pull boxes smaller than a Type 200 vault, unless approved by the Engineer, prior to installation. The Contractor shall leave a minimum of 100 feet of slack per conduit entrance (200 feet total) in all Type 200 vaults or other pull boxes where fiber optic cable is to be spliced, allowing the splicing activities to take place outside the pull box above ground in a controlled environment.

***DELETE PARAGRAPH “J.2” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

1. The labeling on the fiber optic cable shall be approximately 2 feet from the entry point and shall note the direction of the cable along with its next point of entry (i.e., AMS FIBER North to XYZ St. & ABC Blvd or CFO FIBER West to ABC Blvd. & XYZ St.).

***ADD THE FOLLOWING PARAGRAPHS TO SUBSECTION “J”:***

1. A continuous cable passing through a pull box shall have two labels. A pull box with a trunk line fiber optic cable spliced with a CDCA cable shall have three labels, two on the trunk line fiber optic cable (one at each conduit entrance point) and one on the CDCA cable entry point.

***ADD THE FOLLOWING PARAGRAPHS TO THIS SUBSECTION:***

M. The contractor shall clean new and existing conduits, no more than one week prior to installation of fiber optic cable. Conduit cleaning is not required where existing cables, conductors, or innerducts within a conduit are not to be removed. Conduit cleaning is not required when both end of the conduit have a proper cap/plug that appears to have stopped water and other material from flowing into the conduit. Prior to pulling the mandrel through the conduit, the conduit shall be brushed or swabbed if required by the Engineer.

1. For PVC conduit, a metal-disc mandrel with an outer diameter not less than 90 percent of the conduit’s inside diameter shall be pulled through the conduit.
2. For HDPE conduit, a ball mandrel with an outer diameter not less than 80 percent of the conduit’s inside diameter shall be pulled through the conduit.

N. During all fiber optic cable installations, regardless of installation method, the contractor shall record the "foot marking" of installed fiber optic cable at the entrance and exit point of pull boxes on a “Fiber-Optic Cable Installation Sequential Report”. The report shall be provided to the Engineer in electronic spreadsheet format prior to final acceptance.

1. This electronic spreadsheet shall include a column that calculates the cable slack loop quantity/distance for each pull box location, based on the foot markings of cables that pass through the pull box without a fiber splice. For fiber splice locations the contractor shall also include the foot markings at the end of each cable that enters the splice enclosure. The combined quantity/distance of each cable entering the splice enclosure (i.e., between the pull box entrance and the splice enclosure, plus the distance between the splice closure and the pull box exit point), shall be used to calculate cable slack loop quantity/distance for each cable entering a splice enclosure.
2. Within this spreadsheet also add a column with the GPS coordinates for each pull box location and a column for the associated pull box number as shown on the plans. Refer to section 623 G.01.05, GLOBAL POSITIONING SYSTEM (GPS) COORDINATES for additional requirements.

O. Splicing:

1. The contractor shall perform fusion splicing of fiber optic cable at the locations shown on the splice details in the project plans. Splices shall be prepared in accordance with the manufacturer’s recommendations. Splicing shall be conducted only at splice locations shown on the project plans or in node buildings at fiber termination panel locations.
2. Fiber optic cable shall be continuous between splice points as shown on the splice details in the project plans. Additional splice points proposed by the contractor that are not indicated on the project plans are subject to approval by the Engineer, at no additional cost to the Owner.
3. The contractor shall install splice enclosures in a manner approved by the Engineer. Splice enclosures shall be installed with trunk line cable entries on the same side of the end cap allowing future Communications Distribution Cable Assembly (CDCA) and branch fiber optic cables to be installed without disturbing the trunk line seals.
4. Where the contractor is splicing to existing fiber optic cable, the contractor shall take care not to disturb existing splices. Existing splices that are damaged shall be repaired immediately by the contractor, at no additional cost to the Owner.
5. All splices and connectors shall be prepared in accordance with the manufacturer’s recommendations. Each splice between two new fibers shall introduce less than 0.03 dB attenuation.
	* 1. **TESTING**

***DELETE PARAGRAPH “A.1.e.” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

1. Submit factory results of the AMS and FMS cables for approval by the FAST Director or designee, prior to installing the cable. Submit factory results of the CFO cables for approval by the TED or designee, prior to installing the cable.

***DELETE PARAGRAPHS “A.2.d.” and “A.2.e.” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

1. Submit Optical Time Domain Reflectometer (OTDR) trace results of the AMS and FMS cables for approval by the FAST Director or designee, prior to installing the cable. Submit Optical Time Domain Reflectometer (OTDR) trace results of the CFO cables for approval by the TED or designee, prior to installing the cable.
2. OTDR results for the AMS and FMS cables shall be approved by the FAST Director or designee, prior to installation. OTDR results for the CFO cables shall be approved by TED or designee, prior to installation.

***DELETE PARAGRAPH “A.3.b.1)” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

1. OTDR Tests
2. Conduct tests using an OTDR for each fiber.
3. Demonstrate that the attenuation for each fiber strand complies with the loss budgets required by these Standards.
4. Test all fibers at 1,310 nm and 1,550 nm.
5. Submit OTDR trace results of the AMS and FMS cables for approval and acceptance by the FAST Director, or designee. Submit OTDR trace results of the CFO cables for approval and acceptance by TED, or designee.
6. All OTDR traces shall be provided in the test documentation submittal in their native format or “raw” state as they are saved on the OTDR hard drive. For example, the bi-directional .trc files on an EXFO OTDR shall be submitted above and beyond the pdf’s generated of the OTDR traces.
7. OTDR tests shall be performed in accordance with TIA/EIA-455-8 for all fibers, including new fibers, dark fibers, and existing fibers in splice enclosures that the contractor works in.
8. The contractor shall perform OTDR tests using a launch cable of a length recommended by the OTDR manufacturer. The contractor shall enter the proper OTDR parameters for operation, including wavelength, index of refraction of fiber to be tested, and pulse length. The contractor shall adjust the sensitivity to 0.01 decibel and the resolution to display the complete fiber under test. Each loss event in the OTDR table shall be set to at least 2 decimal places. The contractor shall set the range of the OTDR to capture the complete fiber trace. The contractor shall set the number of averages or time of averages on the OTDR to ensure a smooth trace with no noise at the end of the trace.
9. The contractor shall submit OTDR traces which clearly annotate the location of each loss event at a minimum of 2 decimal places and identify the maximum allowable loss and the measured loss for each event (i.e., connector, splice, and fiber path length). The contractor shall provide a table of bi-directional splice losses for each fiber at each splice point and the table shall also include the connector losses at each termination panel for each fiber for review. All measured losses that exceed the maximum allowable loss shall be clearly identified on the bi-directional splice loss table until corrective measures have been performed by the contractor and all fiber paths successfully pass the OTDR test criteria. Failed splices shall be remade and re-tested for compliance. Failed connectors shall be cleaned, and replaced if necessary, and re-tested for compliance. Failed cable segments shall be replaced and re-tested for compliance.
10. OTDR tests shall be performed as follows:
11. Bi-directional OTDR testing:

The contractor shall test each fiber strand path between fiber termination panels, in both directions, at 1310 nm and 1550 nm utilizing a fiber launch reel to ensure the reflective connector in the patch panel is measured.

In the event that a cable is pulled from point A to point B, with or without splices, but neither end is terminated, rather the ends are in a pull box for a future connection, the contractor shall test each unterminated fiber strand at each end to determine the bi-directional splice losses between the unterminated cables. There will be no front-end connector loss measurements since the cable is not terminated.

1. Uni-directional OTDR testing:

The contractor shall test each fiber strand connected to a fiber termination panel at one end and un-terminated in a splice closure at the other end utilizing a fiber launch reel at the terminated end to ensure the reflective connector in the patch panel is measured.

***DELETE PARAGRAPH “A.3.b.2)” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

1. Power meter readings are required from all fibers. Submit power meter results of the AMS and FMS cables for approval and acceptance by the FAST Director, or designee. Submit power meter results of the CFO cables for approval and acceptance by TED, or designee.

***ADD THE FOLLOWING PARAGRAPHS TO SUBSECTION “A.3.b.2)”:***

1. The contractor shall conduct Power Meter Tests for each fiber to measure installed fiber cable attenuation and demonstrate correct panel termination continuity, for example, fiber #1 at site A matches up with fiber 1 at site B.
2. Power Meter Tests shall be performed on each fiber strand path between fiber termination panels (i.e., CDCA and node termination panels). The contractor shall ensure that the light source and meter are calibrated and referenced to a zero reading when directly connected to each other, ensuring an accurate loss reading.
3. Power Meter Tests shall be performed in accordance with Method A.3 of TIA/EIA-526-7 – “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.” Testing shall be conducted at the cable ends in both directions using 1310 and 1550 nm wave lengths.
4. The contractor shall provide power meter testing results on a Power Meter Test Form. The contractor shall use the Power Meter Test Form illustrated below for recording the power meter results:



1. The contractor may request the Microsoft Excel spreadsheet of this form from TED. If the spreadsheet is not available, then the contract shall create one to use that is pre-approved by the Engineer prior to testing.

***DELETE PARAGRAPH “D” OF THIS SUBSECTION AND REPLACE WITH THE FOLLOWING:***

D. All fusion splices shall be measured by the fusion splicer’s internal diagnostic program when the splice is created, and shall have no greater attenuation that 0.03 db loss.

1. Additionally, all splices shall be noted on the OTDR test documentation, and shall have no greater than a 0.03 db loss.
2. All cables (including the CDCA and Trunk Line Cables) and all splices shall be tested as part of the completely installed system, and shall take place from connector to ST connector, if installed, or from the end the cable run at the outer limits of the project.
3. The use of a “loop-back” testing procedure will be acceptable, if approved by the Engineer in advance of the testing.

***ADD THE FOLLOWING PARAGRAPHS TO THIS SUBSECTION:***

E. FAST shall have in their possession all pre- and post-testing data prior to final approval and acceptance of the AMS and FMS cables by the FAST.

F. The CLV shall have in their possession all pre- and post-testing data prior to final approval and acceptance of the CFO cables by TED.

**METHOD OF MEASUREMENT**

**680.04.01 MEASUREMENT**

***DELETE THIS SUBSECTION IN ITS ENTIRETY AND REPLACE WITH THE FOLLOWING:***

The quantity of FIBER OPTIC CABLE (XX-STRAND) will be measured per linear foot installed, in place, complete and operational, and successfully tested. The cable shall be measured by the marking on the exterior cable sheath. No separate measurement will be made for lubricant in this item.

The quantity of [FILL IN ITEM DESCRIPTION] will be measured per [UNIT].

No direct measurement shall be made for [FILL IN ITEM DESCRIPTION].

**BASIS OF PAYMENT**

**680.05.01 PAYMENT**

***DELETE THIS SUBSECTION IN ITS ENTIRETY AND REPLACE WITH THE FOLLOWING:***

The accepted quantity of FIBER OPTIC CABLE (XX-STRAND) will be paid for at the Contract unit price bid per linear foot, which shall be full compensation for installing the cable and appurtenances, complete in place, and for providing labor, hardware, cable ties, single mode fiber optic cable, lubricant, conductive line locating material, water blocking material, and labeling, all as specified, as shown on the Drawings, and as required by Engineer. All materials required to complete the system shall be incidental to the cable including the approval, furnishing, and installation of racks and hooks in T200 vaults, and removing and replacing existing cables, for each type installed. Payment for the fiber optic cable installation shall also include the cost of all fiber optic termination strips, splices in existing splice enclosures, terminations, and labeling as incidental to the item requiring the work. Testing, warranty, documentation, and spare parts are considered incidental to the item requiring the work.

All other components of the approved Communications Distribution Cable Assembly (CDCA) and splicing in new splice enclosures shall be specified and paid under Section 681, “Fiber Optic Splice and Distribution Equipment”. Testing, temporary connectors for testing, warranty, documentation, training, and spare parts are considered incidental to the item requiring the work.

The accepted quantity of [FILL IN ITEM DESCRIPTION] will be paid for at the contract unit price of [UNIT] and shall include all materials, equipment and labor required including, but not limited to, [FILL IN] and all other items necessary to complete the work as shown on the Plans, as specified herein and as directed by the Engineer.

Unless otherwise provided in the Special Provisions, no payment will be made for [FILL IN ITEM DESCRIPTION] as such. The cost thereof shall be considered as included in the price bid for construction or installation of the items for which [FILL IN ITEM DESCRIPTION] is required.

Payment will be made under:

|  |  |  |
| --- | --- | --- |
| **ITEM NO.** | **ITEM DESCRIPTION** | **UOM** |
| 680.0005 | FIBER OPTIC CABLE (XX – STRAND) | LF |

**END OF SECTION 680**