Addendum No. 4

RFP # 19-10350-8799

Fiber Infrastructure Operations, Maintenance, and Commercialization Services

Prospective Respondents: You are hereby notified of the following information in regard to the referenced RFP:

REVISION

1. Replace the Electronic Version of Appendix G. Price Proposal in its entirety with the revised “Appendix G. Price Proposal_02.27.2020.xlsx” provided as an attachment to this Addendum. The revised Appendix G – Price Proposal incorporates revision(s) made to the “Reoccurring Costs Worksheet” and “Unit Costs Worksheet”.

ADDITION

1. Add Appendix W – Single Unit Item Special Provisions provided as an attachment to this Addendum. The new appendix has been added to provide specifications that correspond with the “Unit Costs Worksheet”.

QUESTIONS AND ANSWERS

Following are the answers to questions submitted in response to the above referenced RFP as of February 18, 2020. All of the questions have been listed verbatim, as received by the Pennsylvania Turnpike Commission.
<table>
<thead>
<tr>
<th>#</th>
<th>Page</th>
<th>Section</th>
<th>Section Description</th>
<th>Proposer Question</th>
<th>Commission Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Can the Commission provide maps of where electrical service is currently available along the proposed project corridor, and where electrical service will be expanded as part of their own projects in the near future? Is there a percentage of the route currently served?</td>
<td>The requested information is not available with the Commission.</td>
</tr>
<tr>
<td>2.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Can the Commission provide average ROW distance from interstate centerline(s) along proposed project corridor?</td>
<td>Typically, the Commission’s Right-of-Way (ROW) have 200’ width on average. Approximately 100’ on either side of the centerline.</td>
</tr>
<tr>
<td>3.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Is there any wireless infrastructure currently in place along the Commission’s ROW?</td>
<td>Yes. Presently, there are macro cell towers in the Commission’s ROW. Additionally, the Commission’s ROW includes wireless communications infrastructure for field devices including Intelligent Transportation System (ITS), gates, closed-circuit television (CCTV) and land mobile radio systems.</td>
</tr>
<tr>
<td>4.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>One-Time Costs Worksheet</td>
<td>Can the Commission clarify if the first table (FOM-5.3) under One-Time Costs is the total anticipated units per site or across all (20) existing Cashless Toll sites? Should we assume the installation of all (20) happen at the same time?</td>
<td>Yes. FOM 5.3 applies to all 20 existing Cashless Tolling sites. Proposers should assume that all 20 sites will be available for installation by late 2021.</td>
</tr>
<tr>
<td>5.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>One-Time Costs Worksheet</td>
<td>Should FOM-5.3 units include all labor, materials, and mobilization? If all sites will not be built in same dispatch, will the Commission consider adding a mobilization unit to cover mobilization and set up and reduce per unit fees?</td>
<td>A line item under FOM 5.3 has been added to address mobilization per Cashless Tolling site. Proposers should assume that all 20 sites will be available for installation by late 2021.</td>
</tr>
<tr>
<td>#</td>
<td>Page</td>
<td>Section</td>
<td>Section Description</td>
<td>Proposer Question</td>
<td>Commission Response</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
<td>---------</td>
<td>---------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>6.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>One-Time Costs Worksheet</td>
<td>For the FMS implementation, should the O&amp;M vendor carry license and other 3rd party software costs in the lump sum price? Or will the Commission be paying those fees directly or on a pass through basis?</td>
<td>Yes, the O&amp;M vendor should plan to carry these costs. Proposers should include all re-occurring costs associated with the FMS implementation, associated licenses and other 3rd party software costs in line item FOM-3 Fiber Management System S-3A Reoccurring FMS, ArcGIS, ESRI, etc. licenses provided in “Reoccurring Costs Worksheet”.</td>
</tr>
<tr>
<td>7.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>One-Time Costs Worksheet</td>
<td>Regarding FOM-4: Can the Commission clarify what is expected for level of effort and anticipated quantities for Witnessing and Acceptance as a lump sum? Rather, would the Commission be willing to pay for these activities under T&amp;M rates?</td>
<td>Proposers should estimate their efforts associated with Witnessing and Acceptance testing. No change is made to the payment method for this item.</td>
</tr>
<tr>
<td>8.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>One-Time Costs Worksheet</td>
<td>Regarding FOM-4: Would the Commission please provide D-B contracts EN-00232-03-02 &amp; EN-00232-03-03 as stated for reference?</td>
<td>Proposers can obtain the DB contracts for EN-00232-03-02 and EN-00232-03-03 on the Commission’s Electronic Bidding System (EBS) site (<a href="https://ebs.paturnpike.com/generalinformation/">https://ebs.paturnpike.com/generalinformation/</a>). These documents can be found under the Bids tab. Please note that user registration as a business partner on the Commission’s EBS site is required to access these documents.</td>
</tr>
<tr>
<td>9.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>One-Time Costs Worksheet</td>
<td>Regarding Independent Verification: Can the Commission quantify the level of effort expected in independent verification to better provide a lump sum price? Would the commission consider hourly rates for these activities?</td>
<td>Proposers should estimate their efforts associated with the Independent Verification and Validation. All costs should be included in OTHER S-6 FR-1.6 Independent Verification and Validation provided in “Reoccurring Costs Worksheet”.</td>
</tr>
<tr>
<td>#</td>
<td>Page</td>
<td>Section</td>
<td>Section Description</td>
<td>Proposer Question</td>
<td>Commission Response</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
<td>---------</td>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>10.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>Unit Costs Worksheet</td>
<td>How does the Commission propose to compensate for minimal work mobilizations?</td>
<td>Proposers should note that a new line labeled “U-21 Mobilization” has been added in “Unit Costs Worksheet” of the Appendix G – Price Proposal.</td>
</tr>
<tr>
<td>11.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>Unit Costs Worksheet</td>
<td>Should proposers carry fees for 24/7 services in unit rates? Or will the Commission add a yearly retainer?</td>
<td>Proposers should provide their unit costs / rates to meet the operational performance standards required by the RFP.</td>
</tr>
<tr>
<td>12.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>Unit Costs Worksheet</td>
<td>Will the Commission add a unit for mobilization to cover minimum dispatch?</td>
<td>Proposers should note that a new line item labeled “U-21 Mobilization” has been added in “Unit Costs Worksheet” of the Appendix G – Price Proposal.</td>
</tr>
<tr>
<td>13.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>Unit Costs Worksheet</td>
<td>Would the Commission please provide specification documents with complete description of the units U-1 through U-20 for accurate pricing?</td>
<td>Appendix W has been added with specifications for the units U-1 through U-23.</td>
</tr>
<tr>
<td>14.</td>
<td>N/A</td>
<td>Appendix K</td>
<td>SLA</td>
<td>Is the Commission willing to negotiate the terms and conditions of the disincentives outlined in the RFP and more specifically, FR-2 and Appendix K?</td>
<td>Proposers should submit their responses in accordance with the terms and conditions of the disincentives included in the RFP and Appendix K.</td>
</tr>
<tr>
<td>15.</td>
<td>N/A</td>
<td>Appendix G</td>
<td>Unit Costs Worksheet</td>
<td>Regarding Note 5: Please clarify how changes to quantities shall be handled as OT-4 represents a Lump Sum cost associated for this work based on a fix quantity.</td>
<td>Note # 5 on the “Unit Costs Worksheet” has been revised and moved to “One Time Costs Worksheet”. Quantities for OT-4 are not expected to change.</td>
</tr>
<tr>
<td>16.</td>
<td>Section FR-1.16</td>
<td>Environmental Requirements</td>
<td></td>
<td>Would the Commission be open to providing the services outlined in this section as pass-through basis? It is not reasonable to assume provisions for items such as approvals, permitting, and environmental mitigation measures without known conditions or quantities.</td>
<td>The Commission expects that major environmental requirements will be addressed as part of “Separate LOA” and the method of compensation can be determined at the time of executing such “Separate LOA”.</td>
</tr>
<tr>
<td>#</td>
<td>Page</td>
<td>Section Description</td>
<td>Proposer Question</td>
<td>Commission Response</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>--------</td>
<td>---------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Section FOM 4-1</td>
<td>New Fiber Installation</td>
<td>Regarding construction meeting attendance, please provide parameters for meeting frequency and duration.</td>
<td>Proposers should note that these meetings will generally be held monthly and will commence on July 2020 and onwards. On average, such meetings are expected to last approximately 2 hours each.</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>79 of 96</td>
<td>FOM-3 Fiber Management System</td>
<td>The licensing costs for a cloud-based FMS are typically recurring on a monthly or annual basis. Where in the pricing sheets should the recurring costs for the FMS be input?</td>
<td>Yes, the O&amp;M vendor should plan to carry these costs. Proposers should include all re-occurring costs associated with the FMS implementation, associated licenses and other 3rd party software costs in line item FOM-3 Fiber Management System S-3A Reoccurring FMS, ArcGIS, ESRI, etc. licenses provided in “Reoccurring Costs Worksheet”.</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>81 of 96</td>
<td>FOM-3.1 FMS Inventory Management</td>
<td>This question relates to data collection and data entry for the purpose of building the FMS and mapping. Are any of the existing fiber assets or those currently under construction documented in electronic format such as CADD or GIS? If yes, are those available for the bidder to review?</td>
<td>For existing fiber assets, the Commission does not have any records in CADD or GIS format. For the new fiber assets to be constructed under Design-Build Contracts, the Commission will provide requested in electronic format such as CADD or GIS when ready.</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>84 of 96</td>
<td>FOM-3.4 ESRI/GIS Integration</td>
<td>Will the FMS be able to use Commission provided ArcGIS licenses for the ESRI/ARC support and integration?</td>
<td>No. The Commission will not provide any ArcGIS user licenses for the ESRI/ARC support and integration in support of this contract. Proposers should include all re-occurring costs associated with the FMS implementation, associated licenses and other 3rd party software costs in line item FOM-3 Fiber Management System S-3A Reoccurring FMS, ArcGIS, ESRI, etc. licenses provided in “Reoccurring Costs Worksheet”.</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Page</td>
<td>Section</td>
<td>Section Description</td>
<td>Proposer Question</td>
<td>Commission Response</td>
</tr>
<tr>
<td>-----</td>
<td>-------</td>
<td>---------</td>
<td>--------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>21.</td>
<td>1 of 2</td>
<td>U-2</td>
<td>Unit Costs Worksheet</td>
<td>Please specify the dimensions of the micro-trench required including depth and width.</td>
<td>Typical dimensions of the micro-trench is 1.5” – 2” width by 16” depth.</td>
</tr>
<tr>
<td>22.</td>
<td>1 of 2</td>
<td>U-3 &amp; U-4</td>
<td>Unit Costs Worksheet</td>
<td>Please define Type I and Type II Trenching and Backfilling units U-3 and U-4.</td>
<td>Type I and Type II Trench and Backfill shall meet the requirements identified in PennDOT Publication 408, Sections 910.3(c), 910.4(n), and 954 and as detailed in PennDOT Publication 148, TC-8804, Sheet 2 of 2 modified to 36” (min) depth of conduit.</td>
</tr>
<tr>
<td>23.</td>
<td>1 of 2</td>
<td>U-13</td>
<td>Unit Costs Worksheet</td>
<td>Please verify that U-13 Fiber Terminations is to be a per fiber price.</td>
<td>Confirmed.</td>
</tr>
<tr>
<td>24.</td>
<td>1 of 2</td>
<td>U-17</td>
<td>Unit Costs Worksheet</td>
<td>Please verify that U-17 Fiber Splice is to be a per fiber price.</td>
<td>Confirmed.</td>
</tr>
<tr>
<td>25.</td>
<td>1 of 2</td>
<td>U-20</td>
<td>Unit Costs Worksheet</td>
<td>U-20 Maintenance and Protection of Traffic can vary greatly per mile depending on time of day, date, location, number of lanes, etc. Could a typical be provided? If not, how should this be priced?</td>
<td>Proposers should refer to Maintenance and Protection of Traffic standards and plans available on the Commission’s website for an example MPT scenario. For more information refer to link provided in Section FR-1.17 of the RFP.</td>
</tr>
<tr>
<td>26.</td>
<td>1 of 2</td>
<td>General</td>
<td>Unit Costs Worksheet</td>
<td>Due to the locations of some assets, some work will include night work in order to avoid lane closure issues. Can the Unit price worksheets be modified to include options for Straight time and Premium time work?</td>
<td>For the purposes of preparing responses, Proposers should use straight time to estimate the costs.</td>
</tr>
<tr>
<td>#</td>
<td>Page</td>
<td>Section</td>
<td>Section Description</td>
<td>Proposer Question</td>
<td>Commission Response</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
<td>---------</td>
<td>---------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>27.</td>
<td>N/A</td>
<td>General</td>
<td></td>
<td>Due to complexities of the requirement and the financial and performance commitments required of the Proposer, will the Commission consider conducting one on ones with the Proposer and its team members prior to the response due date?</td>
<td>The Commission is not planning to conduct any one-on-one meetings with Proposers prior to the OMC RFP due date.</td>
</tr>
</tbody>
</table>

All other terms, conditions and requirements of the original RFP dated December 18, 2019, Addendum # 1, Addendum # 2, and Addendum # 3 remain unchanged unless modified by this Addendum.

*****
APPENDIX W

Single Unit Item Special Provisions
## SPECIAL PROVISIONS INDEX

### A. PROJECT SPECIFIC PROVISIONS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-1</td>
<td>MICRO-DUCT BUNDLE</td>
<td>1</td>
</tr>
<tr>
<td>U-2</td>
<td>MICRO-TRENCHING AND RESTORATION</td>
<td>2</td>
</tr>
<tr>
<td>U-3</td>
<td>TRENCHING AND BACKFILL, TYPE I</td>
<td>3</td>
</tr>
<tr>
<td>U-4</td>
<td>TRENCHING AND BACKFILL, TYPE II</td>
<td>4</td>
</tr>
<tr>
<td>U-5</td>
<td>DIRECTIONAL BORING</td>
<td>4</td>
</tr>
<tr>
<td>U-6</td>
<td>JUNCTION BOX WITH ROUND COVER</td>
<td>5</td>
</tr>
<tr>
<td>U-7</td>
<td>FLEXIBLE DELINEATOR POSTS</td>
<td>6</td>
</tr>
<tr>
<td>U-8</td>
<td>FIBER OPTIC CABLE. SM, 288 STRAND</td>
<td>7</td>
</tr>
<tr>
<td>U-9</td>
<td>FIBER OPTIC TERMINATION PANEL AT DEMARCATION SITES</td>
<td>12</td>
</tr>
<tr>
<td>U-10</td>
<td>FIBER OPTIC CABLE SPLICE ENCLOSURE</td>
<td>13</td>
</tr>
<tr>
<td>U-11</td>
<td>CABLE INSTALLATION INSIDE BUILDING</td>
<td>14</td>
</tr>
<tr>
<td>U-12</td>
<td>CABLE RACKS INSIDE BUILDING</td>
<td>14</td>
</tr>
<tr>
<td>U-13</td>
<td>FIBER TERMINATIONS</td>
<td>14</td>
</tr>
<tr>
<td>U-14</td>
<td>WALL PENETRATION</td>
<td>15</td>
</tr>
<tr>
<td>U-15</td>
<td>TEMPORARY AERIAL FIBER OPTIC CABLE, 288 STRAND</td>
<td>16</td>
</tr>
<tr>
<td>U-16</td>
<td>35’ WOOD POLES</td>
<td>20</td>
</tr>
<tr>
<td>U-17</td>
<td>FUSION SPLICE</td>
<td>21</td>
</tr>
<tr>
<td>U-18</td>
<td>FIBER TESTING</td>
<td>21</td>
</tr>
<tr>
<td>U-19</td>
<td>ROOT CAUSE ANALYSIS</td>
<td>23</td>
</tr>
<tr>
<td>U-20</td>
<td>MAINTENANCE AND PROTECTION OF TRAFFIC</td>
<td>23</td>
</tr>
<tr>
<td>U-21</td>
<td>MOBILIZATION</td>
<td>27</td>
</tr>
<tr>
<td>U-22</td>
<td>HDPE COMMUNICATIONS CONDUIT</td>
<td>27</td>
</tr>
<tr>
<td>U-23</td>
<td>JUNCTION BOXES, JB-1</td>
<td>29</td>
</tr>
</tbody>
</table>
U-1 MICRO-DUCT BUNDLE

U-1.01 Description – This work is furnishing and installation of eight (8) bundled micro-ducts within micro-trench.

U-1.02 Material – Submit to the PTC for approval a micro-duct meeting the following characteristics:

A. Micro-duct bundle shall have outer sheathing composed of HDPE.

B. Micro-duct bundle quantity, sizing and orientation shall be determined by the Contractor and shall be utilized consistently throughout the length of the project.

C. Micro-duct bundle(s) shall contain integrated tracer wire(s). Tracer wire(s) shall not be installed within the inner micro-duct(s).

D. Micro-ducts shall be of adequate inside diameter to accommodate the overall size of the micro-fiber optic cable as defined by the manufacturer and detailed in the contract documents. Size the micro-ducts appropriately to accommodate the micro-fiber optic cable. All (8) micro-ducts used throughout the project shall be the same size.

E. Micro-duct shall be recommended for direct bury installation by the manufacturer.

F. Micro-duct couplings to maintain continuity of the conduit path.

U-1.03 Construction – Install micro-duct in accordance with all manufacturer recommendations and best practices.

Typical micro-duct installation in micro-trench shall consist of a total of eight (8) bundled micro-ducts. Micro-duct bundle(s) shall be composed of micro-ducts wrapped in an outer sheathing as described in U-1.02. Of the eight (8) total micro-ducts to be installed, one (1) micro-duct shall be dedicated for backbone fiber, and one (1) micro-duct shall be dedicated for distribution fiber. When installing micro-duct bundle(s) in micro-trench, orient the bundle(s) so the backbone and distribution micro-ducts are at the bottom of the trench. Cap all micro-ducts immediately upon installation to preserve the integrity of each individual micro-duct for the duration of the project. Remove applicable caps only to test the integrity of the ducts, and to install new fiber optic cable. Unused ducts not containing fiber optic cable are to remain capped. All caps shall be installed as per the manufacturer’s recommendations to provide a watertight installation.

Each of the eight (8) individual micro-ducts shall have a unique color scheme. If the Contractor determines to install multiple micro-duct bundles, each individual bundle shall have a different color scheme, and each outer sheathing wrapping each bundle shall be of a different color. Colors shall not repeat. Maintain the same color scheme throughout the length of the project.

Contractor shall determine and submit to the Commission the size, quantity and orientation of the micro-duct bundle(s). The Contractor shall maintain a consistent installation of micro-duct bundle(s) within new micro-trench throughout the project. Contractor shall make every effort to match the color, size, quantity and orientation scheme set forth by the D/B Contractor.

Testing – After micro-duct installation is complete, each individual micro-duct shall be
proofed with a BB. Do not install pull lines in micro-duct. Select a BB of appropriate diameter to proof each micro-duct. The BB diameter must be 80% of the inner diameter of the individual micro-duct.

Attach a high-pressure air supply using a quick-connect fitting of the appropriate size for the micro-duct being tested at one end. At the opposite end of the micro-duct, cover the end of the duct with a sturdy mesh bag or sock to collect the BB once it has traveled through the entire length of the micro-duct. Secure the bag or sock with tape or a cable tie to verify the BB exits the far end of the micro-duct. Perform this testing under the supervision of the QC Manager to witness the successful collection of the BB. Use a minimum air pressure of 75 psi. Use extreme caution and use best safety practices when performing this work as the BB will exit the microduct with considerable pressure.

Should a BB become lodged in the micro-duct, apply high-pressure air at the far end of the duct to try to dislodge the BB. If applying air from the far end does not remove the BB, blow a BB of the next size smaller diameter to help dislodge the stuck BB.

Failure to pass the BB through the micro-duct constitutes failure of the test. If the test fails, recheck all air connections and perform the test again. All micro-duct that does not pass the second clearance test shall be considered non-conforming and subject to corrective procedures. All connections of the micro-duct along the route shall be checked for proper connection. The BB test shall be repeated until the location(s) of non-conforming micro-duct can be isolated and repaired. All corrective testing and repair of non-conforming duct shall be performed at no additional cost to the Commission.

U-1.04 Measurement and Payment – Linear Foot.

U-2 MICRO-TRENCHING AND RESTORATION

U-2.01 Description – This work is excavating micro-trench and restoring the trench.

U-2.02 Material – Furnish a durable reinstatement material meeting or exceeding the following specifications:

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
<th>ASTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids Content</td>
<td>100%, SCAQMD compliant</td>
<td>D2369</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>≥5,000 psi</td>
<td>D412</td>
</tr>
<tr>
<td>Concrete Adhesion</td>
<td>900 psi; 100% substrate failure</td>
<td>D7234</td>
</tr>
<tr>
<td>Compressive Strength at 5% strain, 3d RT cure</td>
<td>1,500 ±300 psi</td>
<td>C579 Method B C109</td>
</tr>
</tbody>
</table>

The Manufacturer shall certify the reinstatement material is suitable for the following applications:

- Roadway installations within micro-trenches and joints in concrete or asphalt
- Freeze-thaw resistant for durability in cold climates
- Slope and grade applications and can be installed on incline/decline
- Black in color
- Topping sand available in Black or Natural color
Bulletin 15 approved materials are not required for this application. One acceptable product is FastPatch 8400; however, any reinstatement material in compliance with these provisions is acceptable. It is the Contractor’s responsibility to demonstrate the reinstatement material meets or exceeds the requirements of this specification.

U-2.03 Construction – Excavate micro-trench of sufficient depth to provide 13 inches of cover to the top of the highest duct. Micro-trench shall be of sufficient width to comfortably accommodate the bundled micro-duct(s) as specified herein.

Install micro-trench in the shoulder as shown in the contract documents outside of the Sonic Nap Alert Pattern (SNAP) without causing any damage to the SNAP. Any damage to the SNAP caused by the Contractor shall be repaired at no additional cost to the Commission.

Do not install micro-trench across ramps.

Do not install marking tape within the micro-trench.

Backfill and restore micro-trench with a durable reinstatement material meeting or exceeding the requirements outlined in U-2.02. Top with a topping sand that closely approximates the color and texture of the roadway. Do not remove shoulder restrictions until the Commission verifies micro-trench has been restored with backfill that is rigid and flush with surrounding pavement.

Micro-trench must be installed flush with the surrounding roadway without settlement. Any trenches found to be insufficiently backfilled, improperly cured or improperly bonded must be repaired by the Contractor at no additional cost to the Commission.

U-2.04 Measurement and Payment – Linear Foot.

U-3 TRENCHING AND BACKFILL, TYPE I

U-3.01 Description – This work is the excavation of Type I (unpaved surfaces) trench and backfilling in accordance with PennDOT Publication 408, Sections 910 and 954 and TC-8804.

U-3.02 Construction – In accordance with Sections 910 and 954 and as follows:

Spider plow trenching is an acceptable method of construction.

Where conduit is to cross a drainage pipe or other lateral obstruction, identify the location in the field with paint or another method acceptable to the Commission prior to beginning trenching operations and provide suitable crossing method.

Install metallic warning tape, orange in color, for fiber trenches.

Install conduit in trench at a minimum of 36” depth. Maintain a minimum clearance of 6 inches between power and communications conduits when placed in the same trench.

U-3.03 Measurement and Payment – Linear Foot. The price includes excavation, backfilling,
temporary and permanent plastic trench markers, and surplus material disposal. No allowance will be made for rock excavation or for any other subsurface condition encountered. Unless otherwise authorized, no allowance will be made for additional trench lengths as a result of deviation from the indicated trench locations.

**U-4 TRENCHING AND BACKFILL, TYPE II**

**U-4.01 Description** – This work is the excavation of Type II (sidewalk/paved shoulders) trench and backfilling in accordance with PennDOT Publication 408, Sections 910 and 954 and TC-8804.

**U-4.02 Construction** – In accordance with Sections 910 and 954 and as follows:

Where conduit is to cross a drainage pipe or other lateral obstruction, identify the location in the field with paint or another method acceptable to the Commission prior to beginning trenching operations and provide suitable crossing method.

Install metallic warning tape, orange in color, for fiber trenches.

Install conduit in trench at a minimum of 36” depth. Maintain a minimum clearance of 6 inches between power and communications conduits when placed in the same trench.

**U-4.03 Measurement and Payment** – Linear Foot. The price includes excavation, backfilling, temporary and permanent plastic trench markers, and surplus material disposal. No allowance will be made for rock excavation or for any other subsurface condition encountered. Unless otherwise authorized, no allowance will be made for additional trench lengths as a result of deviation from the indicated trench locations.

**U-5 DIRECTIONAL BORING**

**U-5.01 Description** – This work includes directional boring to install conduit in accordance with PennDOT Publication 408, Section 954. Provide all labor, materials and equipment required to meet the requirements for the directional boring. Use of directional boring will be allowed at the discretion of the Commission.

**U-5.02 Material** – Includes 6” HDPE Casing Pipe:
- 6” diameter HDPE DR11 Casing Pipe
- Minimum wall thickness of 0.487 inches
- Rating of 128 psi

**U-5.03 Construction** – In accordance with 954.3(b) and as follows:

A. Preparation
   All excavation, sheeting, shoring, bracing, and dewatering must comply with the applicable requirements of Publication 408 and the requirements of the applicable authorities.

B. Installation
   1. Directional boring Installation
      a. The directional boring method must consist of pushing the pipe into the fill with a boring auger rotating inside the pipe to remove the spoil.
b. Provide the front of the casing pipe with suitable mechanical arrangements or devices that will positively prevent the auger and cutting head from leading the pipe so that there will be no unsupported excavation ahead of the pipe.

c. The equipment and mechanical arrangements or devices used to drill and remove the earth and/or rock must be removable from within the casing pipe in the event an obstruction is encountered.

d. The face of the cutting edge must be arranged to provide reasonable obstruction to the free flow of soft or poor soil.

e. Do not use water or other liquids to facilitate casing emplacement or spoil removal.

U-5.04 Measurement and Payment – Linear Foot.

U-6 JUNCTION BOX WITH ROUND COVER

U-6.01 Description – This work consists of the furnishing and installing a junction box with round cover.

U-6.02 Material – Provide junction boxes that meet the following requirements:

A. Junction box dimensions shall be, at a minimum, the dimensions shown in Attachment D of the D/B Contract EN-00232-03-03.
B. Junction box lid shall be a circular, gray, solid cast iron, non-skid cover with a minimum dimension of 32” in diameter and minimum 1.5” thick. Lid shall be permanently marked with the text “PTC COMM” with 2” raised letters.
C. Junction box shall be designed to be capable of accommodating a minimum of four (4) cable rack supports within junction box. Cable rack supports to be installed in boxes where required as per the contract documents. Cable rack supports are not required to be fabricated with the junction box.
D. Provide knockouts in junction box walls as shown in Attachment D of the D/B Contract EN-00232-03-03.
E. Provide an 8” x 8” square hole in the bottom center of the junction box for drainage.
F. Provide (4)-1” diameter ground rod holes at the corners of the drainage hole.
G. Junction box shall be designed using PHL-93 Live Load with Load and Resistance Factor Design (LRFD) in accordance with AASHTO LRFD Bridge Specifications, 7th Edition 2014 and PennDOT, DM-4.
H. Reinforcement and details for the junction box and top slab to conform to RC-46M.
I. Ensure the ring and cover are made of gray, solid cast iron and comply with AASHTO M105, Class 35B and AASHTO M306.
J. Provide certification by a Professional Engineer registered in the Commonwealth of Pennsylvania for design calculations showing the junction box meets all loading requirements.
K. Junction box cover and frame to be in accordance with the requirements of RC-39M.
L. Flowable Backfill as per Section 220.
M. Superpave Mixture Design Binder and Wearing Course as per Section 409.
O. Cement Concrete as per Section 704.

U-6.03 Construction –
A. Install the junction box within the paved shoulder as required.
B. Notify and obtain approval from the Commission of any planned deviations from the typical installation location as shown in the D/B Contract EN-00232-03-03 contract documents.
C. Contractor shall sawcut clean lines in the field for the removal of asphalt prior to junction box installation. Clean lines shall be maintained when asphalt is removed. Broken edges of asphalt shall not be acceptable.
D. Excavate a maximum of 1’ on each side beyond the footprint of the junction box.
E. Set the top of the ring and cover flush with the finished surface of the roadway. The maximum allowable depression is ½”. The ring and cover shall in no way protrude above the surface. At the Contractor’s option, the junction box may be installed so the junction box is not level in areas of significant cross slope or superelevation. Otherwise, acceptable adjustment rings must be utilized.
F. Install (1)-4” conduit from the junction box to a minimum of 24” beyond the paved shoulder for future connections. Ensure conduits enter the junction box perpendicular to the walls or as approved by the Commission. Maintain a 2” separation between adjacent walls, conduits and cable racks. Cap and seal both ends of the conduit stub-out.
G. After installation of conduit, completely seal all open recesses with brick and grout.
H. Provide and install ground rods as per NEC requirements.
I. Provide Flowable Backfill, Type B, around all sides of the junction box after construction. Install Flowable Backfill as per Section 220.
J. Restore pavement to final grade as per Section 409. Replace materials in-kind. If cement concrete is necessary, install as per Section 704.
K. Seal around the new pavement with Rubberized Joint Sealing Material – ASTM D6690-Type 1.

U-6.04 Measurement and Payment – Each

U-7 FLEXIBLE DELINEATOR POST

U-7.01 Description – This work consists of the furnishing and installing flexible delineator post of the type and color indicated.

U-7.02 Material – Sections 937.2 and 1101.09 and as follows:

A. As listed in Bulletin 15 – Color: Orange.
B. Decals – Non-reflective, weather resistant with warning message of Buried Fiber Optic Cable.

U-7.03 Construction –

A. Install decals, sheeting, letters, and numbers on the posts as indicated on the D/B Contract EN-00232-03-03 contract drawings and Standard Drawings.
B. For soil installations use a chisel pointed, drivable, reusable metal anchor into which the post is inserted and held in place with a locking mechanism.
C. After placing the conduit,
   a. Install orange flexible delineator posts where the conduit passes under the edge of paved shoulder;
   b. Install orange flexible delineator posts at each junction box and at horizontal bend
points, as indicated and as directed by the Commission, to identify the conduit as underground fiber optic cable. Where junction boxes are installed within the pavement, install the delineator posts outside of the shoulder as close to the junction box as practicable.


U-8 FIBER OPTIC CABLE, SM, 288 STRAND

U-8.01 Description – This work consists of the furnishing, installing, terminating and testing of single-mode micro-fiber optic cable, including all mounting hardware. Refer to the special provisions for D/B Contract EN-00232-03-03 for additional information.

U-8.02 Material – In accordance with Section 1204.2(a) and as follows:
  A. Recommended for underground conduit installation by the manufacturer.
  B. General. Certify the manufacturer meets the following requirements and submit proof to the Commission.
    a. ISO 9001 and ISO 14001 certified manufacturer
    b. TL 9000 registered quality management system
  C. Outside Plant Cable (OSP). The cable shall meet the requirements of ANSI/ICEA Draft Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA 744, and IEC 60794-5-10. Fiber optic cable meeting the following general requirements:
    a. Permanently identify each reel of fiber optic cable with a label listing, but not limited to, the following:
       i. Cable type and number
       ii. Gross weight
       iii. Cable length
       iv. Job order number
       v. Date of manufacturing
       vi. Date of factory test
    b. Provide a data sheet with each reel containing the factory test results for each fiber in the cable. The following information, at a minimum is to be included:
       i. Cable number
       ii. Factory Order Number
       iii. Customer Purchase Order Number
       iv. Measured Attenuation of Each Fiber
       v. Ordered Length
       vi. Actual Shipped Length
  Submit all data sheets to the QC Manager for review and approval prior to installation. Complete this review within 15 business days of receipt of material.

D. Single Mode Optical Fiber.

E. Cable Construction.
  a. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be between 1.4 - 1.95mm. The buffer tube shall have a dual-layer construction with polycarbonate PC inner layer and polybutylene terephthalate (PBT) outer layer.
b. Each buffer tube shall contain up to 36 fibers.

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

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

e. The fibers shall be colored with ultraviolet (UV) curable inks.

f. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding."

g. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and shall not be subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

h. In buffer tubes containing more than 12 fibers, fiber identification will utilize a black tracer method. The first 12 fibers will be the standard color; fibers 13 through 24 will repeat the same color identification with black tracer, with the exception of fiber 20: “the second black fiber”. This fiber will be opaque (transparent coating) with black tracer. Fibers 25 through 36 will repeat the same color identification with two black tracers. This helps uniquely identify the fibers.

i. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.

j. 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. Fillers shall be nominally between 1.4 – 1.95 mm in outer diameter.

k. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be over-coated with a PE up-jacket when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

l. Each buffer tube shall be filled with a non-hydroscopic, homogenous gel that is nonnutritive to fungus and electrically non-conductive. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional non-toxic solvents. Gel is only permissible within buffer tubes.

m. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process.

n. Cables shall contain tear features 180° apart for easy sheath removal without the need for ripcords. The tear feature shall open only when the sheath halves are pulled apart at end of the sheath or a mid-span ring-cut opening. The tear feature shall not open during handling, installation, or operation.

o. Cables shall be sheathed with polyethylene (PE). The nominal jacket thickness shall be 0.5 mm. Jacketing material shall be applied directly over a cable core thin-film binder.

p. The HDPE jacket material shall be as defined by ASTM D1248, Type III, Class D, Category 3 and Grade J4.

q. The jacket or sheath shall be free of holes, splits, and blisters.

r. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

s. Cable jackets shall be marked with the manufacturer’s name, 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. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white.

t. The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be -5°C to +60°C.

F. Cable Performance Specifications

a. When tested in accordance with IEC 60794-1-22, “Optical fiber cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods” for Temperature Cycling, the change in attenuation at extreme operational temperatures (-40°C and +70°C) for a minimum cable length of 1,000 meters after two cycles, shall not exceed 0.15 dB/km at 1550 nm for single-mode fiber.

b. When tested in accordance with IEC 60794-1-22, “Optical fiber cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods” - Water Penetration test: a three-meter length of unaged cable shall withstand a one-meter static head or equivalent continuous pressure of water for 24 hours without leakage through the open cable end.

c. When tested in accordance with IEC 60794-1-21, “Optical fiber cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods” – Compound Drip: the cable shall exhibit < 0.05 grams flow (drip or leak) of filling and/or flooding material at 70°C for 24 hours.

d. When tested in accordance with IEC 60794-1-21, “Optical fiber cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods” – Crush Under Load (Compressive Loading): the cable shall withstand a minimum compressive load of 50 N/cm applied uniformly over the length of the sample for one minute, with attenuation change to be equal to or less than 0.05 dB after removing the load.

e. When tested in accordance with IEC 60794-1-21, “Optical fiber cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods” – Impact Test: At room temperature: one impact with a 300 mm radius hammer (1Nm) in three locations 150 mm apart, optical measurements after each impact not to increase more than 0.15dB, also no cable damage or broken fibers. At room temperature: Two impacts with a 12.5 mm NA hammer (2Nm) in three locations 150 mm apart, optical measurements after each the two impacts not to increase more than 0.15dB, also no cable damage or broken fibers. Cold Impact: At -10°C, two impacts with a 12.5 mm NA hammer (2Nm) in three locations 150 mm apart – no splitting or jacket damage.

f. When tested in accordance with IEC 60794-1-21, “Optical fiber cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods” – Impact Test: At room temperature: one impact with a 300 mm radius hammer (1Nm) in three locations 150 mm apart, optical measurements after each impact not to increase more than 0.15dB, also no cable damage or broken fibers. At room temperature: Two impacts with a 12.5 mm NA hammer (2Nm) in three locations 150 mm apart, optical measurements after each the two impacts not to increase more than 0.15dB, also no cable damage or broken fibers. Cold Impact: At -10°C, two impacts with a 12.5 mm NA hammer (2Nm) in three locations 150 mm apart – no splitting or jacket damage.

g. When tested in accordance IEC 60794-1-21, “Optical fiber cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods” – Tensile Test: the cable shall withstand a rated tensile load of 350 N (75 lb) for 6 positions and 1000N (225 lb) for 8 and 12 positions during tensile load
application. The axial fiber strain shall be ≤ 60% of the fiber proof level after completion of 60 minute conditioning and while the cable is under the rated installation load and attenuation increase not to increase more than 0.1 dB. The axial fiber strain shall be ≤ 20% of the fiber proof level after completion of 10 minute conditioning and while the cable is under the residual load. The change in attenuation after load removal shall not exceed 0.05 dB at 1550 nm for single mode fiber.

h. When tested in accordance with IEC 60794-1-21, “Optical fiber cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods” – Torsion (Twist) Test: a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting +/- 180 degrees. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.

i. When tested in accordance with IEC 60794-1-21, “Optical fiber cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods” – Hot/Cold Bend: the cable shall withstand four full turns around a mandrel of 20 times the cable diameter after conditioning for four hours at test temperatures of -30°C and +50°C – repeat 3 times. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears, or other openings. The change in attenuation shall not exceed 0.10 dB at 1550 nm for single mode fiber.

j. When tested in accordance with IEC 60794-1-22, “Optical fiber cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods” – Thermal Aging: The cable shall be exposed to +85 °C for 168 hours. Optical measurements are not required during this phase. After the ageing steps, perform a temperature cycling test according to Method F1. Perform two full cycles. At the end of the last cycle, the temperature shall be lowered to +23°C, which shall be maintained for 24 hrs., and the attenuation shall be measured. At the final +23°C temperature, attenuation measurements shall be performed. The maximum allowable attenuation increase shall be: at 1550 nm, 0.25 dB/km, maximum, and an average of 0.10 dB/km.

k. When tested in accordance with IEC 60794-1-21, “Optical fiber cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods” – Cable Kink test performed as follows: A loop shall be made and the diameter of the loop shall be reduced to the onset of kinking by pulling slowly on the two ends. When the kinking begins, stop pulling. The Kink OD is not more than 40 X the cable OD. Measure the length of the cable in the loop, C, beginning and ending at the crossover point. Calculate the equivalent loop “diameter” by applying the formula: \( d = \frac{C}{\pi} \).

l. Maximum Jacket Eccentricity measured with ASTM D4565: not to exceed 40%.

m. When tested in accordance with IEC 60794-1-21, “Optical fiber cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods” - Buffer Tube Kink test performed as follows: A loop shall be made and the diameter of the loop shall be reduced to the onset of kinking by pulling slowly on the two ends. When the kinking begins, stop pulling. The Kink OD is not to be more than 60 mm. Measure the length of the tube in the loop, C, beginning and ending at the crossover point. Calculate the equivalent loop “diameter” by applying the formula: \( d = \frac{C}{\pi} \).

n. When tested in accordance with Telcordia GR-20: FOTP 244 and RUS PE 90 buffer tubes shall pass Temperature Cycling (-40°C to +70°C) as follows: GR-20, 14 feet
of buffer tube expressed in three loops with the following diameters: 75mm, 120mm, and 210mm, max attenuation change allowed is no greater than 0.15dB after two cycles. RUS PE 90: 20 feet of buffer tube expressed in three loops with the following diameters: 75mm, 120mm, and 210mm, max attenuation change allowed is no greater than 0.10dB and average allowed is no greater than 0.05dB after five cycles.

o. When tested in accordance with EN 60068-2-17 and EN 60068-2-18 for closure testing, no leaks will occur where bubbles are present or water ingresses into the closure after the following test parameters are applied: 40kPa for 15 minutes and 100kPa for seven days.

p. When tested in accordance with TIA/EIA – 598c, buffer tubes shall meet the colors as specified in the Munsell Chart after visual inspection.

U-8.03 Construction – In accordance with Section 1204.3(a) and as follows:

The Contractor is responsible for furnishing, installing and testing the micro-fiber optic cable of the size and type required. The Contractor is responsible for appropriately sizing the micro-fiber optic cable so it can be safely installed within the microducts, as well as any other raceways, new and existing.

The ends of the fiber optic cable on each reel shall be protected with caps and shall be accessible for testing before installation. If damage to cables is suspected at any time, the Commission may request a retest of all suspected cable, at the Contractor’s expense, within 48 hours of notification.

Contractor shall be responsible for verifying that the overall diameter of the fiber optic cable is of appropriate size to be safely installed within the selected micro-ducts.

Store all cable in accordance with the manufacturer's recommendations. Install and terminate the cable as per the manufacturer’s recommendations.

All fiber optic cable installed within micro-duct shall be blown through with a BB. Pulling a mandrel shall not be allowed.

Backbone fiber shall be installed in a manner that it is only spliced to provide a continuous path between network hub demarcation sites.

Distribution fiber shall be installed in a manner that it provides a continuous path to local splices to connect Commission assets and demarcation sites.

Intermediate complete cable splices shall only be permitted to connect cable from two different cable spools.

Fusion splices are the only permitted splicing method for fibers.

At no time shall any cable, buffer tube or fiber be subjected to a bend radius less than 15 times its outer jacket diameter.

All cable slack loops shall comply with the minimum bend radius for that cable, buffer tube or fiber. All cable slack loops shall use loop rings, brackets or similar methods to ensure loop
radius integrity. Where multiple cable slack loops are required at the same location, loop and secure separately each cable.

Cable must be attached to the wall of a junction box or manhole in a manner which does not adversely affect the integrity of the box. Cable must not lie at the bottom of the junction box or manhole.

Provide cable tags of weather resistant, non-ferrous metal, nylon, or other non-conductive material. Cable tags shall be printed sealed labels for readability and longevity and shall be provided for each fiber optic cable at the demarcation points, junction boxes, splice points, and other areas where the fiber optic cable is terminated or is exposed.

Submit all installation procedures for review and approval by the Commission prior to installation. Complete this review within 20 business days of receipt of material.

Maintain fiber optic cable assignment records of all assignments and splicing charts for all strands of broadband cables installed as part of the project. Coordinate with the Commission’s fiber O&M Contractor as necessary to maintain these records.

Testing – Test the fiber in accordance with U-18.

U-8.04 Warranty – The Contractor shall coordinate with the fiber optic cable manufacturer to provide a fully transferable twenty (20) year material warranty to the Commission.

U-8.05 Measurement and Payment – Linear Foot. Price for testing of fiber to be captured in U-18.

U-9 FIBER OPTIC TERMINATION PANEL AT DEMARCATION SITES

U-9.01 Description – Provide rack-mountable Fiber Termination Panels (FTP) for the splicing and termination of fiber optic cable.

U-9.02 Material – Fiber terminations must be performed at a termination panel.

FTP shall be Corning Closet Connector Housing (CCH) Four-Rack (4U) units - Part Number – CCH-04U.

Contractor to provide compatible Corning CCH cassettes for storing fiber splices and slack for both used and unused fibers within the panel. Provide splice trays as specified and required.

Utilize factory terminated LC type pigtail connectors of the size required for the fiber optic cable to perform terminations.

U-9.03 Construction – Install the FTP in a consistent, vertical orientation at each Demarcation Site. Orient each termination panel so front access is provided to the terminated fibers.

Fiber shall be terminated in Corning CCH cassettes compatible with the provided termination panel.

Individually identify (label, tag) all fibers in the FTP.
Terminate LC connectors in single mode fiber pigtailed fusion spliced to the fiber optic cable as required.


U-10 FIBER OPTIC CABLE SPLICE ENCLOSURE

U-10.01 Description – Perform and install underground fiber splices within the splice enclosures inside of junction boxes as required in the Contract Documents and as described within these specifications below. Contractor shall furnish the appropriately-sized splice enclosure at the appropriate locations. Each fiber shall be fusion spliced for each location required.

U-10.02 Material – House all fiber optic splices in fiber optic splice enclosures, which shall include organizer trays, brackets, clips, cable ties, seals and sealant, and other miscellaneous items as required for a full and complete installation. Provide splice enclosures that meet the following requirements:

A. Splice enclosures shall be compatible with the proposed Fiber Optic Network.
B. Splice enclosures shall be rigid non-filled case.
C. Splice enclosure case shall be molded out of flame-retardant polyester/polycarbonate steel.
D. All splice enclosure hardware shall be corrosion resistant aluminum or stainless steel.
E. Unless otherwise approved, all splice enclosures shall be of the same manufacturer and model.
F. Splice enclosures shall have the capability of accommodating all fiber fusion splices required.
G. Splice enclosures shall provide storage for fiber splices, non-spliced fiber and buffer tubes.
H. Splice enclosures shall be rodent-proof, re-enterable, waterproof and airtight.
I. Splice enclosures shall employ re-usable materials that allow for multiple re-entrances without replacing any components. Re-entrances shall not require specialized tools or equipment.
J. Splice enclosures that are designed for use under the most severe conditions such as moisture, vibration and impact, and are designed for a temperature range of -40°C to +70°C (-40°F to +158 °F).
K. Provide separate splice enclosures for backbone and distribution fiber optic cables. A splice enclosure shall not contain both backbone and distribution cables.

U-10.03 Construction – The splice enclosure is to be installed according to the manufacturer’s recommended guidelines.

The Contractor must affix the splice enclosure to the side of the manhole or junction box using cable support brackets. All cables must be properly dressed and affixed to rails or racks within the manhole or junction box. No cables or enclosures will be permitted to lie on the floor.

U-10.04 Measurement and Payment – Each.
U-11 CABLE INSTALLATION INSIDE BUILDING

U-11.01 Description – This work is furnishing and installing of fiber optic cable within 2” Exposed Rigid Galvanized Steel conduit in Commission buildings.

U-11.02 Material – Sections 910.2, 954.2, 1104.5 and as follows:

Conduit - Section 1101.09(c)1
Cable – U-8

U-11.03 Construction – Sections 910.3 and 954.3, and as follows:

Install conduit in buildings using approved methods. Submit drawing for approval by the Commission prior to construction detailing cable routing plan and attachment hardware for each building. Use existing hangars where available. When penetrating walls, repair walls around conduits to original characteristics. When installing conduit in non-linear sections for fiber optic cable, install conduit sweeps, obeying minimum cable bending radius.


U-12 CABLE RACKS INSIDE BUILDING

U-12.01 Description – This work is the furnishing and installation of equipment racks at demarcation sites.

U-12.02 Material – Provide the following:

Equipment Racks shall be Chatsworth Two-Post Universal Rack, Two Top Angles, 19” EIA Channel Width, Gray, 41 U height (6’-6”) - Model Number 46353-102.

U-12.03 Construction – The Commission will designate space at each identified site for the Contractor to furnish and install one (1) rack at the site.

Spacing of rack mounting shall allow for vertical cabling sections between proposed rack and future Commission provided racks.

The Contractor is responsible for coordinating the necessary locations with the Commission and furnishing, installing and integrating the equipment as necessary at each location. The Contractor is responsible for coordinating space for future additional Commission owned equipment.


U-13 FIBER TERMINATIONS

U-13.01 Description – This work is the termination of fibers at the termination panels.

U-13.02 Material – Provide the following:
Appendix W

- Type LC, as indicated, for fiber connections to new equipment. The Contractor shall field verify the type to be used for fiber connections to existing equipment.
- Telcordia GR-326 Issue 3 compliant and as specified under these requirements, whichever requirement is more stringent shall apply.
- Uses ceramic ferrules.
- Fiber secured within the ferrule with epoxy, in accordance with the requirements of the connector or epoxy manufacturer.
- A strain relief mechanism shall be provided for coupling the connector to the fiber’s aramid strength member.
- Operating temperature: -40-degree F to +158 degree F
- Insertion loss: <0.25 dB typical individual loss, 0.4 dB maximum when measured in accordance with FOTP-171.
- Return loss: <-55 dB when measured in accordance with FOTP-10

U-13.03 Construction – Where optical fibers are to be connected to terminal equipment, provide connectors with factory-installed fiber pigtails of sufficient length, plus five feet of slack, and splice them to the corresponding optical fibers. Do not field install connectors. Provide fiber optic pigtails buffered and strengthened with aramid to reduce the possibility of accidental damage to the fiber or connection. Properly protect unused optical fibers with sealed end caps.

Replacement: If the above-specified cable, splice, and termination criteria are not met, replace the entire section of cable.


U-14 WALL PENETRATION

U-14.01 Description – This work is the installation of a wall penetration at PTC facilities and demarcation sites.

U-14.02 Material – Provide the following:

Two (2) 12”x12”x6” NEMA 3R metallic lockable enclosures
2” Rigid Galvanized Steel (RGS) conduit along exterior building wall and within penetration

Submit all product cut sheets to the Commission for review and approval before installation.

U-14.03 Construction – Coordinate with the Commission on the location of the wall penetration, all communications paths and termination points within the building.

Drill a 2-1/2” diameter hole a minimum of 36” from the existing grade in the building at the agreed upon location. Install a 2’ GRS conduit within the hole with bushings on the conduit ends. Seal penetration with sealant consisted with NEC requirements.

Install the NEMA 3R metallic lockable enclosures on the outside and inside of the building at the location of the penetration.

Provide 2” exposed RGS conduit from the exterior enclosure to along the building
underground where it shall transition to HDPE conduit within 6” below grade. Secure RGS conduit to wall using anchors and hot-dipped galvanized steel straps.


U-15 TEMPORARY AERIAL FIBER OPTIC CABLE, 288 STRAND

U-15.01 Description – This work consists of the furnishing, installing, terminating and testing of single-mode fiber optic cable for temporary aerial installations.

U-15.02 Material – In accordance with Section 1204.2(b) and as follows:

A. Gel-free, loose-tube optical fiber cables.
B. Recommended for aerial installation by the manufacturer
C. General. Provide in accordance with U-8.02B.
D. Outside Plant Cable (OSP). The cable shall meet the requirements of ANSI/ICEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-2016, GR-20- CORE Issue 4, and the United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 (PE-90). Fiber optic cable meeting the following general requirements:
   a. Permanently identify each reel of fiber optic cable with a label listing, but not limited to, the following:
      i. Cable type and number
      ii. Gross weight
      iii. Cable length
      iv. Job order number
      v. Date of manufacturing
      vi. Date of factory test
   b. Provide a data sheet with each reel containing the factory test results for each fiber in the cable. The following information, at a minimum is to be included:
      i. Cable Number
      ii. Factory Order Number
      iii. Customer Purchase Order Number
      iv. Measured Attenuation of Each Fiber
      v. Ordered Length
      vi. Actual Shipped Length
   Submit all data sheets to the Commission for review and approval prior to installation. Complete this review within 15 business days of receipt of material.

E. Single Mode Optical Fiber.

F. Cable Construction.
   a. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 2.5mm. The buffer tube shall be polypropylene.
   b. The fibers shall not adhere to the inside of the buffer tube.
   c. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding."
   d. The fibers shall be colored with ultraviolet (UV) curable inks.
   e. Buffer tubes containing fibers shall be color coded with distinct and recognizable
colors in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding."

f. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and shall not be subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

g. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.

h. 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.

i. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod (optional steel central member). The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be overcoated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

j. Each buffer tube shall contain water blocking material embedded in the inside wall of the buffer tube for water-blocking protection. The water blocking material shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This material will preclude the need for other water-blocking materials such as gels, yarns, foams, or tapes; the buffer-tube shall be gel-free.

k. The optical fibers shall not require cleaning before placement into a splice tray or fan-out kit.

l. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process.

m. Cables shall contain tear features 180° apart for easy sheath removal. The tear feature shall open only when the sheath halves are pulled apart at end of the sheath or a mid-span ring-cut opening.

n. The tear feature shall not open during handling, installation, or operation.

o. Cables shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.3mm. Jacketing material shall be applied directly over cable core and water swellable tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

p. The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.

q. The jacket or sheath shall be free of holes, splits, and blisters.

r. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

s. Cable jackets shall be marked with the manufacturer’s name, 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. 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 2.5mm.

t. If the initial marking fails to meet the specified requirements (i.e., improper text statement, color, legibility, or print interval), the cable may be remarked using a contrasting alternate color. The numbering sequence will differ from the previous numbering sequence, and a tag will be attached to both the outside end of the cable and to the reel to indicate the sequence of remarking. The preferred remarking color
u. The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be -30°C to +70°C.

G. Cable Performance Specifications
a. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation at extreme operational temperatures (-40°C and +70°C) shall not exceed 0.15 dB/km at 1550 nm for single-mode fiber and 0.3 dB/km at 1300 nm for multimode fiber.

b. 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.

c. When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable," the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at 70°C.

d. 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 0.15 dB at 1550 nm for single-mode fibers and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber and 0.30 dB at 1300 nm for multimode fiber.

e. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," except that the number of cycles shall be two at three locations along a one meter cable length and the impact energy shall be at least 4.4 Nm (in accordance with ICEA S-87-640)”, the change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber and 0.30 dB at 1300 nm for multimode fiber.

f. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a rated tensile load of 2670N (601 lbf) and residual load of 30% of the rated installation load. The axial fiber strain shall be ≤ 60% of the fiber proof level after completion of 60 minute conditioning and while the cable is under the rated installation load. The axial fiber strain shall be ≤ 20% of the fiber proof level after completion of 10 minute conditioning and while the cable is under the residual load. The change in attenuation at residual load and after load removal shall not exceed 0.15 dB at 1550 nm for single mode fiber and 0.30 dB at 1300 nm for
multimode fiber.
g. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber and 0.30 dB at 1300 nm for multimode fiber.
h. When tested in accordance with FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components," the cable shall withstand a simulated lightning strike with a peak value of the current pulse equal to 55 kA without loss of fiber continuity. A damped oscillatory test current shall be used with a maximum time-to-peak value of 15μs (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half-value of the waveform envelope shall be from 40 to 70μs.
i. When tested in accordance with FOTP -37, "Low or High Temperature Bend Test for Fiber Optic Cable," the cable shall withstand four full turns around a mandrel of ≤ 20 times the cable diameter after conditioning for four hours at test temperatures of -30°C and +60°C. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears, or other openings. The change in attenuation shall not exceed 0.30 dB at 1550 nm for single mode fiber and 0.50 dB at 1300 nm for multimode fiber.

U-15.03 Construction – In accordance with Section 1204.3 and as follows:

The Contractor is responsible for furnishing, installing and testing the temporary aerial fiber optic cable.

The ends of the fiber optic cable on each reel shall be protected with caps and shall be accessible for testing before installation. If damage to cables is suspected at any time, the Commission may request a retest of all suspected cable, at the Contractor’s expense, within 48 hours of notification.

Store all cable in accordance with the manufacturer's recommendations. Install and terminate the cable as per the manufacturer’s recommendations.

Backbone fiber shall be installed in a manner that it is only spliced to provide a continuous path between network hub demarcation sites.

Distribution fiber shall be installed in a manner that it provides a continuous path to local splices to connect Commission assets or demarcation sites.

Intermediate complete cable splices shall only be permitted to connect cable from two different cable spools.

Fusion splices are the only permitted splicing method for fibers.

At no time shall any cable, buffer tube or fiber be subjected to a bend radius less than 15 times its outer jacket diameter.

All cable slack loops shall comply with the minimum bend radius for that cable, buffer tube or fiber. All cable slack loops shall use loop rings, brackets or similar methods to ensure loop radius integrity. Where multiple cable slack loops are required at the same location, loop and secure separately each cable.
The maximum pulling tension shall be 2700 N (600 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

Provide cable tags of weather resistant, non-ferrous metal, nylon, or other non-conductive material. Cable tags shall be printed sealed labels for readability and longevity and shall be provided for each fiber optic cable at the demarcation points, junction boxes, splice points, and other areas where the fiber optic cable is terminated or is exposed. Provide labels for broadband patch cables at the demarcation points and other locations where patch cables are utilized.

Submit all pulling procedures for review and approval by the Commission prior to installation. Complete this review within (20) business days of receipt of material.

Maintain fiber optic cable assignment records of all assignments and splicing charts for all strands of the broadband cables installed as part of the project.

**Testing** – Test the fiber in accordance with U-18.

**U-15.04 Warranty** – The Contractor shall coordinate with the fiber optic cable manufacturer to provide a fully transferable twenty (20) year material warranty to the Commission.

**U-15.05 Measurement and Payment** – Linear Foot. Price for testing of fiber to be captured in U-18.

**U-16 35’ WOOD POLES**

**U-16.01 Description** - This work is furnishing and installation of a wooden utility pole to install aerial communications service lines.

**U-16.02 Materials** - Furnish southern yellow pine, Class 7 wooden poles that conform to ANSI Specification 05.1. Provide 35’ wooden poles with a minimum circumference of 1.75 feet on the top, 2.63 feet at the height of 6 feet from the base. Provide chemical preserved treated pole.

Furnish, as part of the pole assemblies, the following material if required:

- Required length of galvanized steel messenger cable of 0.43-inch diameter made of seven strands and conforming to ASTM-A75, Class A Specification.
- Single strand lashing wire 0.006-inch diameter and made of Type 430 stainless steel.
- Suspension and attachment hardware made of galvanized steel, hardware galvanized in accordance with ASTM-A153 Specification.

**U-16.03 Construction** - Pole treatment process to conform to AWPA-C4 and to provide retention of CCA dry salts of 0.6 lb per cubic feet. Install the poles within the Commission’s right of way. Install tension messenger cable at 60 degrees for the poles as directed by the Representative. Dead end messenger cable at the poles as directed by the Representative. Install poles, in accordance with the current specifications and standards of NELA, EE1 and NESC. Dig holes with vertical sides and with a diameter large enough to permit use of a mechanical tamper around the pole. The installation of the poles is subject to the inspection and approval by the Representative prior to backfilling.
Provide down guys as needed.

Provide plate on the pole indication owner (PTC), contact phone number (800-332-3880) and pole number. Use the first four numbers of the location latitude and longitude for the pole numbering convention.

U-16.04 Measurement and Payment - Each.

**U-17 FUSION SPLICE**

U-17.01 **Description** – This work is providing fusion splices on fiber optic cable as required.

U-17.02 **Materials** – Provide all required equipment and consumable supplies.

U-17.03 **Construction** – Splice all optical fibers, including spares, to provide continuous runs. Do not provide a full splice of the fiber optic cable, i.e., all fibers within the cable being spliced, more frequently than once every 5,000 feet. Store 60 feet of slack cable at each splice location, 30 feet on either side of the splice.

For connection of the fiber optic cable to fiber optic distribution panel or splicing to other cables, cut only those fibers needed for the connection or splice. Use splice trays to hold the spliced and un-spliced fibers, with each fiber neatly secured to the tray. Contain all buffer tubes entirely within the splice tray, with no tubes being exposed.

Package each spliced fiber in a protective sleeve or housing. Completely re-coat bare fibers with a protective, room-temperature vulcanizing (RTV) coating, gel or similar substance as recommended by the cable manufacturer, prior to application of the sleeve or housing, so as to protect the fiber from scoring, dirt, or microbending.

Fusion splices are the only permitted splicing method for fibers.

U-17.04 Measurement and Payment - Each.

**U-18 FIBER TESTING**

U-18.01 **Description** - This work is testing of fiber optic cable after installation.

U-18.02 **Construction** – Test the fiber in accordance with Section 1201 and as follows:

**Pre-Installation Testing** – All fiber optic cable is to be 100% attenuation tested. The attenuation of each fiber is to be provided with each cable reel as indicated in the Materials section above.

The Contractor shall perform pre-installation testing using an Optical Time Domain Reflectometer (OTDR) and Optical Source/Power Meter on all fiber optic cable prior to any cable removal from the shipping reel as indicated below. Perform tests on cable reels delivered to the job site. Submit all data to the QC Manager for review and approval prior to installation. Complete this testing within 15 business days of receipt of material.
Operational Acceptance Testing - Contractor shall be responsible for acceptance testing of the Commission infrastructure. Systems acceptance testing shall be clearly noted in the QC Plan and at least twenty (20) business days’ notice given prior to commencement of testing. In addition to planned systems acceptance testing, future tests may be requested and scheduled at the request of the Commission. The Contractor shall be responsible for the costs of all systems acceptance testing and shall allow for the Commission to witness the tests at the Commission’s discretion.

Stand-alone test all fiber infrastructure after field installation is complete, including all splices and terminations. Test optical fibers in the cable from termination panel to termination panel. The Commission infrastructure shall be tested to verify functionality of the fiber using the following procedure:

1. Prior to installation and integration of the Commission-specified fiber optic terminations, splices and cable will be installed between endpoints in segments.
2. The test will begin when all fiber terminations, splices, and cable have been installed in a segment.
3. Tests will be performed to ensure all fiber and terminations are functioning within specification.
4. A summary of the resulting data as well as the data in its raw format shall be submitted for processing and review by the Commission.

The Contractor shall be responsible, and the Commission shall assist and observe for operational acceptance testing of the Commission infrastructure. Operational acceptance testing shall be clearly noted in the Plan and commence after completion of each segment. Operational acceptance testing shall be a period of sixty (60) days following the completion of each segment. Network connectivity for all demarcation points within that segment shall be tested and verified functional to good industry practice.

If any fiber maintenance issues shall arise during the operational acceptance testing period, they shall be reported to the Commission in writing and resolved at no cost to the Commission. For each maintenance issue, the Commission shall have the sole authority to extend the operational acceptance testing period for an additional thirty (30) days.

Performance Criteria - For both pre-installation testing and operational acceptance testing, include both bi-directional OTDR tests and Optical Attenuation tests for all stand-alone testing for each fiber in each cable.

Have a Certified Technician utilizing an OTDR and Optical Source/Power Meter conduct the installation test. The Technician is directed to conduct the test using the Standard Operating Procedure as defined by the Manufacturer of the test equipment. Ensure that the method of connectivity between the OTDR and the cable is a factory patch cord of a length equal to the "dead zone" of the OTDR. Optionally, the Certified Technician shall use a factory fiber box of 100 meters minimum with no splices within the box. Conduct the tests at 1310nm and 1550nm for all fiber optic cables.

Any splice with a loss exceeding 0.20dB shall be remade until its loss falls below 0.20dB at no additional cost to the Commission.

Total loss for each fiber shall not exceed 0.35dB/km at 1310nm and 0.25dB/km at 1550nm +0.10dB/splice + 0.50dB/connector. No event shall exceed 0.30dB. If any event is detected
above these parameters, replace or repair that event point at no additional cost to the Commission.

At the completion of the test, provide bound Test Documentation of the test results to the Commission that includes the following:

A. Cable & Fiber Identification
B. Cable ID
C. Cable Location - Beginning and End points
D. Fiber ID, including tube and fiber color
E. Operator Name
F. Date & Time
G. Setup Parameters
H. Wavelength
I. Pulse width (OTDR)
J. Refractory index (OTDR)
K. Range (OTDR)
L. Scale (OTDR)
M. OTDR Test Results
N. Total Fiber Trace
O. Measured Length (Cable Marking)
P. Total Length (OTDR)
Q. Splice Loss/Gain
R. Events > 0.10dB
S. Traces are to also be provided on a diskette in PDF format
T. Optical Source/Power Meter Test Results
U. Total Attenuation
V. Attenuation (dB/km)

Provide these results in tabular form for each location.

U-18.03 Measurement and Payment - Hour.

U-19 ROOT CAUSE ANALYSIS

U-19.01 Description – This work is to provide personnel to perform root cause analysis.

U-19.02 Personnel – Provide appropriate personnel to be able to perform a root cause analysis in accordance with FOM-2.9. Personnel shall be experienced in performing root cause analyses and preparing appropriate reports. These services will be performed Ad-Hoc.

U-19.03 Measurement and Payment - Hour.

U-20 MAINTENANCE AND PROTECTION OF TRAFFIC

U-20.01 Description – This work is the maintenance of traffic and the protection of the traveling public approaching the construction area and within the limits of construction. Refer to D/B Contracts EN-00232-03-02 and EN-00232-03-03 for additional referenced information.
A. Maintenance and Protection of Traffic (MPT) includes furnishing, installing, resetting, relocating, storing, and removal of all traffic control devices necessary during hours of construction and at all other times during the course of this project according to the following:

- Section 901;
- Pennsylvania Turnpike Commission (PTC) Standard Details for Maintenance and Protection of Traffic;
- Pennsylvania Turnpike Commission (PTC) Standard Drawings for Maintenance and Protection of Traffic;
- PA Code, Title 67, Chapter 212, Official Traffic-Control Devices;
- Manual on Uniform Traffic Control (MUTCD);
- Publication No. 35, Approved Construction Materials (Bulletin 35), and to be NCHRP-350 or MASH compliant;
- Special Provisions herein;
- For work within the Commission Right-of-Way, the Commission specifications govern. For work outside the Commission Right-of-Way, the PennDOT specifications govern.

Prepare all Traffic Control Plans (TCP) using English units. The TCPs are to be completed by a Professional Engineer (P.E.) registered in the Commonwealth of Pennsylvania.

TCPs shall be prepared for areas not covered by standards. At a minimum, the Contractor shall prepare a plan and/or narrative for each operation which references the appropriate PTS-900 Series Standard or includes a specific design details according to the Standards and submit to the Commission prior to implementing the traffic pattern. Modifications to the existing TCPs for a stage or phase must be submitted to the Commission prior to or within twenty-four (24) hours of changing the existing TCPs.

B. Mainline Turnpike traffic must be maintained throughout the project at all times by providing and implementing the requirements from the preceding list of publications, manuals, standards, etc., along with, but not limited to the following:

1. Mainline turnpike traffic traveling in the same direction must be maintained on two or three adjacent lanes and cannot be split.

2. During long-term traffic control operations, maintain existing 12-foot wide travel lanes in each direction.

3. Provide traffic control for lane and shoulder closures according to PTS-(910,915,940). Maintain a minimum of 1 mile of unrestricted roadway between patterns on the same side of the road.

4. Lane restrictions will not be permitted during non-working hours, required by Attachment A or Attachment B in D/B Contracts, for any operation requiring a mobile lane restriction, stationary lane restriction, mobile shoulder restriction, or stationary shoulder restriction.

5. Lane and shoulder restrictions not behind temporary concrete barrier excluding junction box delineation are not permitted when work is not being performed at any
location within the work zone for a period of more than 60 minutes. Partial shoulder closures are permitted for a maximum of 24 hours following completion of micro-trench backfill to the level of the adjacent pavement to allow backfill material to achieve a traversable state. Channelizing devices are required to be relocated immediately adjacent to the traffic side of the trench as the backfill operations are completed. All speed reduction signs and shadow vehicles are to be removed in the partial shoulder closure areas at the conclusion of each work shift.

6. Shoulder restrictions for junction box delineation not behind temporary concrete barrier are not permitted when work is not being performed at any location within the work zone for a period of more than 5 calendar days.

7. Lane rental fees will be assessed for each lane closure or traffic obstruction resulting in a lane closure beyond allowable working hours as per D/B Contracts.

8. Access must be provided to PTC maintenance sheds, gates and access ramps at all times.

9. Other Commission Contractor(s) and/or Commission Maintenance Forces may be working adjacent to the work zone(s) during portions of this contract period. The Commission will specify the working sequence of the contracts in order to facilitate coordinated traffic control operations.

10. Do not allow any portion of mainline transitions to be within an interchange area.

11. All equipment is to approach, enter, and depart from working zones in the direction of and with the normal adjacent traffic flow.

12. During non-working hours, steel plate all junction boxes in the shoulder, which are not completed or protected by barrier. Steel plate is to be a minimum of 1 inch thick. Steel plates are not to be used for more than 5 consecutive days or during holiday periods. Steel plates shall not be used on the shoulder from November 1st through April 1st. The use of steel plates in temporary or permanent travel lanes is prohibited. Provide a wedge of milled material at 1 inch per foot along all edges of the steel plate or provide alternate anchoring method. Submit alternate to Commission for approval.

13. If the shoulder work zone, excluding junction box installation, is not protected by temporary concrete barrier or glare screen, all excavated areas on the shoulder must be backfilled so that the drop-off does not exceed 2 inches from the existing adjacent pavement. Also complete any required slope repairs, guide rail replacement, shoulder pavement patching, and remove any obstructions prior to opening the adjacent lane for traffic.

14. Shifting traffic to the median or mainline shoulders is not permitted.

15. Use PennDOT approved vertical panels with self-ballasting bases for channelizing devices. The entire face of the vertical panel visible to traffic is to be reflectorized with PennDOT Type XI approved reflectorized material. Completely remove vertical panels from the roadway so they are not visible to motorists during non-working hours except for junction box delineation on shoulder. Channelizing devices
may be temporarily relocated to the minimum offset to allow for work to be performed, as directed by the Commission. The channelizing devices must remain between traffic and the work zone. Relocate channelizing devices to original position as work progresses.

16. Use signs with Type XI reflectorized material on or within the Turnpike right-of-way.

17. Post mount signs in a manner as not to obstruct shoulders and be clear of work areas. PennDOT approved Type III barricades may be used as conditions warrant and as directed by the Commission.

18. During allowable working hours, use PTS (910-2, 910-3, 915-2, 915-3), Mobile Operation for 2 or 3 Lanes, to cover and uncover signs and install and remove traffic control devices. Workers are not permitted to cross live traffic lanes except in a vehicle or in the interchanges and service plazas. During nighttime hours, provide 1 Multi-Directional Lighting Device on Shadow Vehicle(s) with Truck Mounted Attenuator and each of the Work Vehicle(s).

19. Do not perform any work directly over open lanes of Turnpike/Interstates/ State Routes, Township and local roads, streams, and railroads without adequate shielding or work platforms.

20. All tarping, containment apparatus, work platforms, etc. must be removed over the traffic lane(s) prior to opening the lane(s) to traffic.

21. Provide taper lengths for ramps in work zones according to PTS-940.

22. The Commission is to coordinate the work in any Interchange/Service Plaza area with Fare Collection/Service Plaza personnel. Notify the Commission a minimum of fourteen (14) days in advance of the scheduled work in the Interchange/Service Plaza area.

23. Maintain access for emergency and authorized vehicles to all Interchange and Service Plaza buildings at all times.

24. Maintain access for emergency and authorized vehicles to the Access Ramps and the entrances and exits to the Tunnel Portal Buildings at all times.

25. When utilizing a lane closure for the shoulder work between Milepost A-70.48 and Milepost A- 71.56, establish a single-lane traffic control pattern by closing the northbound right lane as shown on PTS 915 on the south side of the Lehigh Tunnel. The lane closure must be a minimum of 1,320 feet prior to the south portal of the tunnel. Maintain single lane traffic through the tunnel without a tunnel crossover pattern. Set PennDOT approved vertical panels 6 feet into the closed lane at 50 foot intervals through the tunnel. Coordinate with the Commission for the placement of the vertical panels through the Lehigh Tunnel.

26. Be aware and familiar with the location and weather conditions around and on the approaches to the Lehigh Tunnel. Traffic or inclement weather, including the
forecasting of inclement weather, may require the opening of all travel lanes or the
cancellation of work at the time. If work is in progress at the time of notification
from the Commission or the Turnpike detail of the Pennsylvania State Police, be
able to remove all traffic control, equipment, and materials from the tunnel within
one (1) hour.

C. State Routes, Township and County Roads

1. Obtain a Highway Occupancy Permit from PennDOT for work on all State routes
   and provide the final original signed copy to the Commission.

2. When required by PennDOT, provide MPT plans and narrative to PennDOT,
   coordinate work, obtain PennDOT approvals, and provide approval documentation
to the Commission.

3. Submit TCPs for Township and County Roads to the Township or County and the
   appropriate PennDOT District, as required, and a minimum of thirty (30) days prior
to the start of construction for approval.

4. Approval must be received prior to any construction activities or traffic control
   patterns on state, county or township roads.

5. Copy the Commission on all correspondence sent or received.

6. Perform maintenance and protection of traffic according to Publication 212, the
   special provisions, the Standard Details and Drawings, and the TCPs.

7. Furnish, install, maintain and remove all required lights, guides, sandbags and
   appurtenances as deemed necessary by the Commission for the proper maintenance
   and protection of traffic and to warn of any obstruction or hazard to traffic.

8. Post mount signs in a manner as not to obstruct shoulders and be clear of work areas
   unless using portable sign supports. Relocate approach signing as needed.

U-20.02 Measurement and Payment – Mile.

U-21 MOBILIZATION

U-21.01 Description – Mobilization shall be in accordance with PennDOT Publication 408, Section

U-21.02 Measurement and Payment – Lump Sum.

U-22 HDPE COMMUNICATIONS CONDUIT

U-22.01 Description – This work is the furnishing and installation of 2” high-density polyethylene
(HDPE) conduits.

U-22.02 Materials –
a. 2” HDPE Conduit - SDR11 with smooth interior wall and smooth exterior wall. Manufactured in accordance with ASTM F2060 and ASTM D3035 from thermoplastic polymer conforming to the minimum standards defined in ASTM 3350 (See Table 1).

**Table 1 - Resin Properties**
The resin Properties shall meet or exceed the values listed below for HDPE

<table>
<thead>
<tr>
<th>ASTM Test</th>
<th>Description</th>
<th>Values HDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-1505</td>
<td>Density g/CM³</td>
<td>0.941 - 0.955</td>
</tr>
<tr>
<td>D-1238</td>
<td>Melt Index, g/10 min. Condition E</td>
<td>0.05 - 0.50</td>
</tr>
<tr>
<td>D-790</td>
<td>Flexural Modulus, MPa (PSI)</td>
<td>80,000 min.</td>
</tr>
<tr>
<td>D-1693</td>
<td>Environmental Stress Crack Resistance Condition B,F10</td>
<td>96 hrs. min.</td>
</tr>
<tr>
<td>D-638</td>
<td>Tensile strength at yield ((PSI)</td>
<td>3000 min.</td>
</tr>
<tr>
<td>D-746</td>
<td>Brittleness Temperature</td>
<td>-75ºC</td>
</tr>
</tbody>
</table>

b. Plastic Marking Tape, Red - Section 1101.12(e)

c. Pulling Lines - (Woven polyester or Aramid fiber with an average tensile strength in excess of that which is required to pull all proposed service cables) - Muletape as manufactured by Neptco Inc. - Teltek Sales 215-477-5888, Bull-Line; as manufactured by Arno Corp. 1-800-321-7914; or approved equal.

d. Tracer Wire - Provide solid copper, or copper clad steel wire.

**U-22.03** Construction – HDPE Conduit - Section 910.3(g), as indicated, and as follows:

Place conduits such that it is a continuous run with no splicing between junction boxes.

Prevent conduits from twisting during installation and minimize variation in the horizontal and vertical alignment. Orientation of the conduits must be consistent throughout the project in and out of each junction box. Install conduit with the tracer wire in the upper left position, at approximately 10 o’clock on the conduit circumference. A tracer wire shall be included in one conduit in each trench.

At obstructions, taper conduit runs to provide vertical or horizontal offset at a rate of 20:1 or flatter.

Identify the conduits within the trench with 6” wide red plastic marker tape placed a minimum of 12” directly above each conduit.

After placing the conduit between junction boxes, provide red flexible delineator post electrical cable markers as required. Flexible markers are to be placed at the junction box and are to identify the conduit as underground electrical cable.

Install pulling lines in each individual conduit to ensure that the conduit has not been damaged during installation. If conduit is damaged, replace the conduit at no additional expense to the Commission. The pulling lines shall remain in unused conduits for future use by others.
Seal all conduits at both ends with manufacturer’s plugs to make conduits watertight.

U-22.04 Measurement and Payment – Linear Foot.

U-23 JUNCTION BOXES, JB-1

U-23.01 Description – This work is for furnishing and installing junction boxes. This item includes the ground wire, ground rod, exothermic bonding of ground rod, and necessary excavation and backfill.

U-23.02 Material – Sections 910.2, 1101 and RC-81M Standards

U-23.03 Construction – Sections 910.3 and as follows:

Revise Section 910.3(p) by adding:

1. Bond metal framed junction box and cover to ground. The bond shall provide a solid electrical and mechanical connection.

2. Cast the following labels into the covers:

   J.B. 1 – "PENNSYLVANIA TURNPIKE COMMISSION COMMUNICATION CABLE"

3. Ground all junction boxes in accordance with NEC Article 250.

4. Provide a minimum of four- cable support brackets permanently affixed to the wall of the Junction Boxes. Use cable support brackets to support all spare cables and any splice enclosures contained within each junction box.

5. Core out all openings at time of fabrication, or at time of placement. Where multi-cell or standard nonmetallic conduit is terminated, the coring must be no larger than 5- or 3-inches diameter for 4 inch or 2 inch conduit, respectively.

6. Install Junction Boxes as per manufacturer's recommendations. Construct Junction Boxes on top of 12 inches of #57 coarse aggregate; 18 inches in locations subject to flooding and poor drainage.

7. Place in such a manner that after settling the cover will be flush with the grass line. Junction Boxes must be placed six feet (typical) minimum from the edge of the shoulder and twenty feet (typical) minimum from the end of an overpass.