# CITY OF LINCOLN, NEBRASKA, STANDARD SPECIFICATIONS

## CHAPTER 26

### COMMUNICATIONS

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CHAPTER 26
COMMUNICATIONS

26.00 GENERAL

A. MATERIAL TESTS

When any reference is made in these Special Provisions, or in the City of Lincoln Standard Specifications to a standard, such as ASTM, ICEA, IMSA, etc., or a related Specification referred to by reference therein, which states that a certain test is to be made only at the request of the purchaser, it shall be considered that the City does request that such test be made. The tests shall be made at the Contractor's expense and a certified copy of each test shall be submitted to the City’s Project Manager prior to the installation of such material.

The Contractor shall submit to the City’s Project Manager 1 hard copy and 1 electronic (pdf) copy of a complete list of all equipment and materials they intend to install. Catalog cuts and/or Manufacturers model number shall be required for the materials furnished by the Contractor and incorporated into the project. There shall be no substitutes for any of the items on the list without prior written approval of the City’s Project Manager.

B. CONTRACTOR RESPONSIBILITY

The Contractor is responsible to inform the City’s Project Manager of any defect found in the existing communications system encountered as part of this contract. Such defects may include, but not be limited to existing improper splices or existing damaged conduit. The City’s Project Manager and Contractor shall determine a plan and cost to correct said defect.

The Contractor is responsible for locates within the project area, until the final inspection is complete.

C. SUBSTANTIAL COMPLETION

The communications system shall not be considered substantially complete until all items shown on the proposal or called for in any contract document are completed to the satisfaction of the City’s Project Manager excluding seed/sod if outside planting season. The system shall be fully operational in conformance with the Plans and Standard Specifications and these or any other Special Provisions included as part of the project.

Liquidated damages shall continue to accrue until such time as the Work is deemed to be substantially completed by the City’s Project Manager. However, the Contractor may submit a written request to the City’s Project Manager for approval to suspend Work to allow additional time for completion of minor items of the Work. Granting the request for additional time by the City’s Project Manager shall not relieve the Contractor of responsibilities for the completion of those items for which the suspension is requested.
D. INSPECTION COMPLETION

Upon completion of a fully operational fiber optic communications system (including: locate system, fiber cable, and all communications equipment, where applicable), an inspection shall be completed by the City. The Contractor is allowed a defined number of calendar days to complete the following: correct any items as listed on the Inspection Form, return Inspection Form back to City, and correct any subsequent deficiencies identified by inspections until City accepts all work. The Contractor is responsible for providing an electronic format set of plans (as-built drawings) compatible with GIS and/or CAD format, detailing any changes made during construction from the original design. In addition, electronic format of any fiber optic communications system schematics, fiber splice diagrams, and cabinet equipment and connections shall also be provided in above-stated format as acceptable to the City of Lincoln.

Prior to the start of inspection, 1 hard copy and 1 electronic (pdf) copy of as-built plans shall be provided to the City. These as-built drawings shall be labeled “AS BUILT”, with the Contractors initials and date.

The number of days for the inspection process is as follows: For the conduit system: 45 calendar days are allowed for the entire conduit system Inspection and Correction process. The City is allowed 14 calendar days for the initial inspection and 7 calendar days for each additional inspection needed thereafter.

Initial and subsequent City inspections shall be included as part of the calendar days allowed. If the Contractor has not corrected all items on the conduit Inspection form to the satisfaction of the City and has not received final acceptance from the City within the allotted time, the Contractor shall be assessed liquidated damages of $500 per calendar day until all work is completed and deemed acceptable.

E. LOCATE SYSTEM

The locate system is comprised of ground rods, ground bars, fiber locate cable and fiber markers. This system is used by the locate technician to locate communication cables in conduits and indicate were fiber pull boxes are.

All locate system components shall be installed where indicated on the plans.

Ground Bars provide a field wiring terminal for the connection of Fiber Locate Cable.

F. TESTING

1. General

The overall communication system testing shall include a bare end fiber test after installation of the fiber optic cable, and a follow-on test after all final splicing and termination work is completed. On a per project basis, this test procedure may include measuring the loss of fiber installed by others before splicing to it. For each fiber optic link, including spare fibers, determine whether the optical loss is within the limits permitted by these specifications. A link is a continuous segment of fiber between one connector (or unterminated end) and another connector (or unterminated end). When testing links that do not have connectors on both ends, use a mechanical splice to attach a pigtail to the unterminated fiber for the duration of the test.
G. TESTING (Continued)

1. General (Continued)

Acceptance Testing is incidental to the Fiber Optic Cable and will not be paid for separately.

2. Procedures

For each fiber link, follow this procedure:

If the link includes fiber installed by others, use an optical loss test set to measure and record the optical loss over that portion of the link before it is spliced to new fiber.

Calculate the maximum allowable loss for the completed link, both at 1310 nm and at 1550 nm. Use the following formula:

\[
\text{Maximum link loss} = \text{Measured loss over portion installed by others} + (\text{Fiber length in km}) \times (0.35 \text{ for } 1310 \text{ nm and } 0.25 \text{ for } 1550 \text{ nm}) + (\text{Number of fusion splices}) \times (0.05) + (\text{Number of mechanical splices [for temp. connection]}) \times (0.3) + (\text{Number of connections}) \times (0.5)
\]

Provide this calculation to the engineer along with the test results.

If the measured loss exceeds the calculated maximum, use an optical time domain reflectometer and other test equipment to troubleshoot the link. Take whatever corrective action is required, including cable replacement, to achieve a loss less than the calculated maximum.

Test Result Documentation. Prepare a diagram showing all of the links tested in this project. For the portions installed in this project, show the equipment cabinets, splices, and pigtails. On each line representing a link, show the maximum allowable loss and the actual loss. The actual loss shall be the one measured after all corrective actions have been taken. Submit an electronic copy of this diagram to the engineer, along with the calculations for the maximum allowable loss. Submit the diagrams and calculations in an electronic format acceptable to the engineer.

Documentation. Provide the engineer mark-ups of the plans, neat and legible, illustrating as-built versions of the splice and connection diagrams that are contained in the plans.

Certifications. The fiber optic cable shall be factory certified to meet the requirements in this specification. In addition, the manufacturer shall certify that the fiber optic cable has a life expectancy of 20 years.

Guarantee. All items covered by this specification shall carry a two-year guarantee from the date of acceptance against any defects in workmanship or materials.
26.02 FIBER MARKER

A. GENERAL

Fiber Marker shall be a 66" long x 3.9"+, flexible fiberglass post with tapered triangular end for ground installation. Fiber Marker shall have 14" long x 2.8"+ label, that is non-reflective, outdoor-durable, vinyl, with “Warning, Fiber Optic Cable, City of Lincoln, Before digging in this area call 402-441-6855”. Fiber Marker shall be standard APWA orange color, and have a post durability rating for 20+ years outdoor.

B. INSTALLATION

Fiber Marker shall be installed at locations as indicated on the plans by inserting the base end into the soil at a depth of 24", as per the manufacturer’s recommendation. Fiber Marker shall be installed over the top of the fiber conduit as to depict the alignment of fiber conduit directly below the marker.

C. BASIS OF PAYMENT

FIBER MARKER, complete, in place and accepted by the City’s Project Manager, shall be measured as a single unit and shall be paid for at the contract unit price per each for the item. This price shall be full compensation for furnishing and/or installing the fiber marker; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

26.03 BLANK ON PURPOSE
26.04 GROUND BAR

A. GENERAL

Ground Bar shall be 1-UL listed, ANSI Certified, CSA Listed. Ground Bar shall be 14 position. Ground Bar shall be insulated/isolated from the pull box utilizing plastic or nylon standoffs.

Ground Bars shall be all copper or aluminum construction, 6" L x 1/2" H x 1/4" W, with no less than 5 x 3/16" mounting holes. Grounding bar shall be mounted to the side of the pull box using standoffs and shall be placed no less than 6" from the ground rod and 10" from the bottom of the pull box lid.

B. INSTALLATION

Ground Bars shall be installed at locations as indicated on the plans and shall be mounted at the center point of the sidewall of the Pull Box T48 opposite the curb, 6" below the top rim. Ground Bar insulators will need to be mounted with 2 stainless steel machine screws through the sidewalls of the pull box, with 2 stainless steel washers on the outside of the pull box. Ground Bars shall then be mounted to the insulators such that they are insulated from the pull box.

C. BASIS OF PAYMENT

GROUND BAR, complete, in place and accepted by the City’s Project Manager, shall be measured as a single unit and shall be paid for at the contract unit price per each for the item. This price shall be full compensation for furnishing and/or installing the ground bar; for standoffs; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.
26.05 FIBER CABLES

A. TYPES AND CLASSES OF CABLE

All classes of cable shall be on substantially constructed reels, plainly marked as to size, type, and insulation identification. Only 1 length of cable shall be shipped on each reel. All cable must be new. Damaged cable or repairs on damaged cable will not be permitted. All cables shall be stranded copper.

1. Fiber Locate Cable

Fiber Locate Cable shall be a new single conductor #14 AWG type THHN 600-volt, stranded copper. Insulation jacket color shall be orange. UL 44 and UL 854, ICEA S-95-658/NEMA WC-70, C (UL) US Federal spec. A-A-59544. Fiber Locate Cable is incidental to the communications conduits installed and will not be paid for separately.

2. Single Mode Fiber Cable

All Single-Mode Fiber Cable fiber shall be single-mode conforming to ITU-T G652.D. Single-Mode Fiber Cable shall conform to ANSI/ICEA S-87-640 Standard for Optical Fiber Outside Plant Communications Cable. Cable type shall be non-armored, all Dielectric suitable for lashed aerial and duct installation. Single-Mode Fiber Cable shall contain water swellable tape to prevent water intrusion. Strength member of the Single-mode Fiber Cable shall be of a non-conductive type and shall provide strength sufficient for installation and residual loads. The cable sheath shall have length markings in feet, and shall indicate that the unit of measure is feet. The cable shall have an operating temperature range of -40 degrees C to 70 degrees C. Number of single-mode fibers within the Single-mode Fiber Cable shall be specified on the project plans. The cables shall be constructed with twelve fibers per tube.

All fibers shall be suitable for transmission using both 1310 nm and 1550 nm wavelengths. Attenuation shall not exceed 0.35 dB/km and 0.25 dB/km for 1310 nm and 1550 nm signals, respectively.

B. INSTALLATION

1. Fiber Locate Cable

Each locate cable shall be terminated at the conductor terminals on the insulated, isolated Ground Bar affixed to the inside of the pull box and to the ground buss in the cabinet.

2. Single Mode Fiber Cable

Single-Mode Fiber Cables shall be installed in such a manner and by such methods ensuring against harmful stretching of the optical fiber, injury to the jacket, damage to the outer protective covering of the cable, or cable crushing. An approved cable lubricant may be used to aid in pulling through conduit.
B. INSTALLATION (Continued)

2. Single Mode Fiber Cable (Continued)

To provide proper slack in cable, 50’ of extra fiber cable shall be neatly coiled and secured in each pull box with Velcro fasteners. For pull box locations with Splice Enclosures, this means 25’ of additional cable on each side of the Splice Enclosure for a total 50’ of slack. Under no circumstance shall any cable be taped or otherwise bound to another cable. Fiber cable shall be installed in conduit with a suitable cable feeding method to protect the cable and guide it into the duct. Break away pulling swivels rated at 600 lbs. shall be used to ensure that the maximum tensile force for the cable is not exceeded and to prevent cable twisting. Ensure that no residual tension remains on the cable after installation, except the weight of the cable.

Do not install conductors carrying AC power in the same wiring harness as cables carrying control or communications signals.

No splices or joints will be permitted to be drawn inside the conduit, nor shall any splices or joints be made in any cable outside of pull boxes or cabinets.

Single-Mode Fiber Cable shall be installed within the ambient temperature limits specified by the manufacturer.

Arrange all fiber cabling, including fiber optic pigtails, so that any removable assembly can be removed without disturbing cabling that is not associated with the assembly being removed.

Prior to installation, perform such tests as indicated in this provision to confirm that the cable is in good condition and complies with the specifications. Any defects found after installation will be deemed the fault of the contractor.

Install the cable such that the optical and mechanical characteristics of the fiber are not degraded. Do not violate the minimum bend radius or the maximum tension, both during and after installation. During cable installation, keep the bend radius at a minimum of twenty times the outside diameter of the cable.

Cables shall be neatly coiled in fiber optic pull boxes and hung on cable racks as available for organized storage and ease of future access.

Before any cable installation is performed, provide the engineer with a copy of the cable manufacturer’s recommended maximum pulling tensions for each cable size. These pulling tensions shall be specified for pulling from the cable’s outer jacket. Also, provide a list of the minimum allowable cable bending radius and the cable manufacturer’s approved pulling lubricants. Only those lubricants approved by the cable manufacturer will be permitted.

If the cable is pulled by mechanical means, use a clutch device to ensure the allowable pulling tension is not exceeded. Also, attach a strain gauge to the pulling line at the cable exit location, and at a sufficient distance from the take-up device, such that the strain gauge can be read throughout the entire cable pulling operation.
B. INSTALLATION (Continued)

2. Single Mode Fiber Cable (Continued)

Do not leave the let-off reel unattended during a pull, in order to minimize the chance of applying excess force, center pull, or back feeding.

Use an approved lubricant, in the amount recommended by the cable manufacturer, to facilitate pulling the cable. After the cable has been installed, wipe the exposed cable in a pull box, junction box, or cabinet clean of cable lubricant with a cloth before leaving the pull box, junction box, or cabinet. After installation, cut off and discard the first 10 feet of the cable. These 10 feet are not included in the quantities and are considered incidental to the fiber work. Seal the fiber optic cable ends to prevent the escape of the filling compound and the entry of water.

All fiber optic cables installed in pull boxes or cabinet locations shall be neatly and definitively labeled using fiber cable tags provided by the City of Lincoln. These fiber optic cable tag labels shall be labeled by the contractor with the number and direction of fiber cables (to/from) and which fibers are spliced, if any.

All fiber optic cable new or relocated shall be tested by the Contractor with an Optical Time Domain Reflectometer (OTDR). Testing shall be performed after all connectors are complete if the Contractor is expected to perform the connectorization. If the contractor is not expected to perform the connectorization then a bare end test of the fiber shall be performed to test cable integrity after contractor installation. In the case of separate contractors for Fiber Optic Cable install and Fiber connectorization an additional OTDR test will be required of the connectors by the connector contractor after all specified connectors are complete. Testing of fiber optic cable shall be conducted in conformance with the Acceptance Testing section of these provisions.

C. BASIS OF PAYMENT

CABLE, FIBER OPTIC, ___ STRAND, SINGLE MODE complete, in place and accepted by the City’s Project Manager shall be measured as lineal feet from center to center of pull boxes, cabinets, or enclosures plus slack coil amounts furnished and installed as specified on the plans of such material of the size and type required and number of fibers. Cable shall be paid for at the contract unit price bid per linear feet.

This price and payment shall be full compensation for furnishing and installing cable, all necessary slack, testing, documentation, connections and all other materials, hardware, labor, equipment, tools, and incidentals necessary to complete the work.

Additional slack cable required inside pull boxes, cabinets, and other such devices or structures, not quantified or indicated on the plans shall be subsidiary to those items and shall not be measured for payment.
26.06 FIBER CONNECTORS, ENCLOSURES AND ACCESSORIES

A. COMPONENTS

1. Fiber SC Connector

All Fiber SC Connectors shall be temperature rated for -40 C to 70 C or better, and shall be compliant with ANSI/TIA-568-B.3 and TIA/EIA-604-3. Fiber SC Connectors shall be SC type compatible with single-mode fiber and shall be terminated using an appropriate Fiber Fan Out Kit. Fan Out Kits are incidental to fiber termination work.

All Fiber SC Connectors shall be installed using the method recommended by the connector manufacturer, and shall be installed compatible with both Fiber Distribution Rack Mount Enclosures, and Fiber Distribution Wall Mount Enclosures.

2. Fiber SC Panel Pigtail

Fiber SC Panel Pigtail shall be temperature rated for -40 °C to 70 °C and shall conform to Design and Test Criteria GR-3152, GR-771. Fiber SC Panel Pigtail shall have 12 SC UPC single mode ports in a housing with an outdoor single mode pigtail of appropriate length for the application. Fiber SC Panel Pigtail shall be wall, or din rail mountable.

3. Fiber Optic Cable Fusion Splice

When a buffer tube is required to be opened in order to perform fusion splicing, cut only the fibers to be terminated/spliced at a location according to the Plans. Unused fibers or fibers that are continuous through a splice location (expressed fibers) are to be coiled, and neatly routed around the inside edges of the splice tray. Fusion splicing will ensure alignment is via fiber cores and splicing equipment shall be fully automated X, Y, and Z axis (3-axis) alignment using a light injection/detection system. Use splicing equipment that has an auto fusion time control to monitor the power level through the splice to complete the fusing process when splice loss is a minimum. Provide splice losses that average less than or equal to 0.05dB/splice between any two optical ports, and do not exceed the same level for any splice. Protect all splices with a thermal shrink sleeve, 60 mm long. Place the completed splices in a splice tray.

4. Fiber Optic Cable Splice Enclosures

Fiber Optic Splice Enclosures shall be listed in the latest edition of the Rural Utilities Service (RUS), List of Materials Acceptable for Use on Telecommunications Systems of RUS Borrowers, category pl, closure design e, suffix B; or be of brand Coyote Fiber Optic Closures, or approved equal. They shall include all materials necessary to make, organize, and protect the splices.

Fiber Optic Splice Enclosure housing shall be non-metallic resistant to solvents, stress cracking, and creep.

Fiber Optic Splice Enclosure shall be re-enterable not requiring encapsulation or potting to resist water penetration.
A. COMPONENTS (Continued)

4. Fiber Optic Cable Splice Enclosures (Continued)

The Fiber Optic Splice Enclosure shall be of a size sufficient to accommodate the number of Single-Mode Fiber Cables and splices specified on the project plans. Fiber Optic Splice Enclosures shall be furnished and installed as either “small” or “large” as defined on the project plans and specs. Fiber Optic Splice Enclosure, Small; shall be able to accommodate a minimum of 48 splices. Fiber Optic Splice Enclosure, Large; shall be able to accommodate a minimum of 144 splices. The Fiber Optic Splice Enclosure shall provide a clamping mechanism to prevent pistoning of the central strength member and to prevent cable sheath pullout.

The Fiber Optic Splice Enclosure shall have appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components in the enclosure and the armored cable sheath. The cable bonding hardware shall be able to accommodate a copper conductor equal to or larger than a No. 6 AWG.

The Fiber Optic Splice Enclosure shall accommodate and include splice trays suitable for single fiber, single fiber heat shrink, mechanical, or ribbon heat shrink splices, and shall accommodate the number of splices specified in the project plans.

A bond clamp shall remain firmly attached to the cable armor sheath while under a tensile load of 9-kg (20 lbf). Following removal of the load, there shall be no evidence of clamp loosening or damage to the cable sheath, armor, or clamp that would reduce its current carrying capacity as required by the AC fault test.

The electrically conductive path used for continuity and grounding of the splice enclosure metallic components shall be capable of withstanding an AC current of 1000 Amperes for 20 seconds.

The cable clamping and sealing hardware used to terminate optical fiber cable shall not cause an attenuation change greater than ±0.05 dB per fiber, when tested with a source operating at 1550 nm ±20 nm.

An axial load of 100 lbf, individually applied to each cable, shall not cause mechanical damage to the cable or clamping hardware. The load to the optical fiber cable shall not cause an attenuation change greater than ±0.05 dB per fiber, when tested with a source operating at 1550 nm ±20 nm.

Subjecting the closure/cable interface to 90° flexing for 8 cycles at ambient temperatures of -18°C ±2°C (0°F ±3.6°F) and 40°C ±2°C (104°F ±3.6°F) shall not cause any mechanical damage to the cable or clamping hardware. In addition, flexing of the optical fiber cable shall not cause an attenuation change greater than ±0.05 dB per fiber, when tested with a source operating at 1550 ±20 nm.

Subjecting the closure/cable interface to 10 cycles of torsional loading at ambient temperatures of -18°C ±2°C (0°F ±3.6°F) and 40°C ±2°C (104°F ±3.6°F) shall not cause any mechanical damage to the cable or clamping hardware. In addition, torsional loading of the optical fiber cable shall not exceed allowable attenuation changes.
A. COMPONENTS (Continued)

4. Fiber Optic Cable Splice Enclosures (Continued)

The enclosure shall not exhibit any mechanical damage after being subjected to a vertical drop from a height of 0.75 m (30") at temperatures of –18°C ±2°C (0°F ±3.6°F) and 40°C ±2°C (104°F ±3.6°F).

The diameter of the optical fiber splice enclosure shall not permanently deform more than 10%, nor temporarily deform more than 20%, when it is compressed by a uniformly distributed load of 300 lbf. Additionally, the compressive load shall cause no mechanical damage to the enclosure or its contents.

The enclosure shall not exhibit any mechanical damage after being subjected to mechanical impact of 100 lbf (136 Nm) at temperatures of – 18°C ±2°C (0°F ±3.6°F) and 40°C ±2°C (104°F ±3.6°F).

The enclosure central member clamp shall prevent movement (e.g. bowing, pistoning, or breaking) of the cable central member (CM) when the CM exerts a force of 100 lbf on the clamp.

Sealing components (gaskets, grommets, O-rings) used in an enclosure, shall not permit the entry of water into the enclosure after thermal aging at 90°C ±1°C (194°F ±1.8°F) for 720 hours (30 days).

The enclosure shall be capable of safe and proper assembly at temperatures of 0°C ±2°C (32°F ±3.6°F) and 40°C ±2°C (104°F ±3.6°F) using materials and procedures specified by the manufacturer.

The enclosure shall not exhibit any mechanical damage or corrosion following 30 days of severe temperature and humidity cycling from 65°C ±2°C (150°F ±3.6°F) and 95% relative humidity to –40°C ±2°C (-40°F ±3.6°F) and uncontrolled humidity. Additionally, at the midpoint of the temperature cycle, re-entry and re-assembly of the enclosure shall be done. If the enclosure has a hinged cover, it shall be flexed 25 times.

The enclosure shall show no evidence of water intrusion into the compartment containing fiber splices after it is immersed in water and subjected to 10 freeze/thaw cycles.

The splice enclosure shall show no evidence of water penetration following exposure to a 20’ waterhead for a period of 7 days.

An enclosure shall show no evidence of corrosion following exposure to acidified saltwater for a period of 90 days.

The enclosure shall show no change in sealing ability after submersion in a specified chemical test fluid for 7 days. The mechanical integrity of the enclosure shall be confirmed by performing the compression and impact tests. The enclosure seal shall also be checked by performing the water immersion test. Additionally, samples of external, nonmetallic enclosure materials shall neither experience a change in weight greater than 10%, nor experience a reduction in tensile strength or elongation properties greater that 20%, after immersion in the chemical test fluid.
A. COMPONENTS (Continued)

4. Fiber Optic Cable Splice Enclosures (Continued)

Samples of external, nonmetallic enclosure materials shall not have a reduction in tensile strength or elongation properties greater than 20% of their original value, after being exposed to a UV-B type ultraviolet light source with a peak emission at 313 nm for 2,160 hours (90 days).

Samples of polymeric enclosure materials shall not support fungus growth when tested per ASTM G 21. A rating of 0 is required.

5. Fiber Distribution Wall Mount Enclosure

Fiber Closet Connector Housing shall be a wall mountable housing capable of housing 4 Fiber SC Closet Pigtails. Closet Connector Housing shall be compatible with SC Closet Pigtails. Closet Connector Housing shall have storage for appropriate splice trays. Closet Connector Housing shall have a hinged door to provide convenient access to installed SC Closet Pigtails and splice trays.

6. Fiber Distribution Rack Mount Enclosure

Fiber Rack Mount Connector Housing shall be a 19" rack mountable housing capable of housing 4 SC Closet Pigtails. Fiber Rack Mount Connector Housing shall be compatible with SC Closet Pigtails. Closet Connector Housing shall have storage for appropriate splice trays. Rack Mount Connector Housing shall have a hinged door to provide convenient access to installed SC Closet Pigtails and splice trays.

7. Factory Terminated Patch Panel w/ Pigtail

Factory terminated patch panels with pigtails will provide for connectivity between field cabinets and fiber optic cable in pull boxes. The factory terminated end will be mounted in the traffic signal or ITS cabinet, and the opposite end of the pigtail shall be spliced in the Fiber Splice Enclosure located in the T48. A fiber splice schematic indicating the fusion splice plan will be provided by the City. The factory terminated patch panels with pigtails shall be provided in either 4-step, skinny (8 fiber port) or 6-step, skinny (12 fiber port) configurations and have type SC connectors. They shall have the following characteristics:

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<th>Single mode</th>
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<tr>
<td>Test wavelength</td>
<td>1550nm</td>
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<tr>
<td>Insertion loss</td>
<td>0.2dB typical, 0.5dB max.</td>
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<tr>
<td>Reflectance</td>
<td>&lt;-55dB (apc connector)</td>
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<tr>
<td>Durability</td>
<td>500 matings, &lt;0.2dB change</td>
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<tr>
<td>Tensile strength - straight pull (cable tail)</td>
<td>50lbs (220N), &lt;0.2dB change</td>
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<td>Temperature range</td>
<td>-40 to +70C</td>
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<td>Ferrule polish</td>
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<tr>
<td>Connector Type</td>
<td>SC</td>
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The Factory Terminated Patch Panel w/ Pigtail, whether 4-step or 6-step, shall be provided with a minimum pigtail length of 75’ unless otherwise noted in special cases.
A. COMPONENTS (Continued)

8. Junction Box

Junction Box shall be 2’ x 2’ x 6” Powder coated steel. Junction Box shall be NEMA 3R rated and shall be lockable.

9. 3”, 3 Cell Fabric Innerduct

3”, 3 Cell Fabric Innerduct shall be 3”, 3 cell polyester/nylon textile innerduct. Fabric Innerduct shall be capable of accommodating up to a 1” diameter cable per cell. Fabric Innerduct shall contain 1250 lb. polyester flat woven pull tape.

B. INSTALLATION

1. Fiber SC Connector

For Single-Mode Fiber Optic Cable the below table specifies minimum acceptable SC Connector performance:

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<th>Loss Mode</th>
<th>Maximum Acceptable Loss (dB)</th>
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<tr>
<td>Single-Mode SC connector (dB loss/connector)</td>
<td>.50 dB max</td>
</tr>
</tbody>
</table>

All OTDR test shall be performed using appropriate launch and receive cables. OTDR submitted test results shall use the full scale of the OTDR display, shall include 2 point loss from launch cable to launch cable, and shall include Optical Return Loss. When testing connectors, a 2 point loss measurement across the connector shall be performed. All testing shall be performed at 1310nm and 1550nm wavelengths.

2. Fiber SC Panel Pigtail

SC Panel Pigtail shall be securely installed where indicated on plans. SC Panel Pigtail shall be mounted in such a way so as to allow easy access. SC Panel Pigtail shall be spliced into existing fiber using a fusion splice. Finished splice shall be housed in a Fiber Splice Enclosure. After installation the SC Panel Pigtail shall be tested with an Optical Time Domain Reflectometer using appropriate launch and receive cables. SC Panel Pigtail shall meet or exceed the below parameters:

<table>
<thead>
<tr>
<th>Loss Mode</th>
<th>Maximum Acceptable Loss (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC Connector Insertion Loss (Per Connector)</td>
<td>.50 dB Max</td>
</tr>
<tr>
<td>SC Panel Pigtail Fusion Splice (Per Splice)</td>
<td>≤ 0.30 Db</td>
</tr>
</tbody>
</table>
B. INSTALLATION (Continued)

3. Fiber Optic Cable Fusion Splice

Fiber Optic Cable Fusion Splice shall be cleaved, cleaned, aligned and spliced according to the fiber splice machine specifications.

Splice shall be protected with either Butterfly or heat shrink splice protection and shall be secured in a splice tray designed for fusion splices.

4. Fiber Optic Cable Splice Enclosure

Installation of Fiber Optic Cable Splice Enclosure shall follow manufacturer’s directions. Installation of Fiber Optic Cable Splice Enclosures in underground Fiber Pull Boxes shall be done in conformance to manufactures directions. Fiber Optic Cable Splice Enclosure shall be neatly hung within the T48 pull box along with excess fiber coils. No Fiber Optic Cable Splice Enclosures shall be permitted for direct burial or in conduit splicing.

5. Fiber Distribution Wall Mount Enclosure

Fiber Distribution Wall Mount Enclosure shall be securely installed where indicated on plans and shall use appropriate mounting hardware. Closet connector housing shall be mounted in such a way as to provide easy access to connector housing access door and the connection points.

6. Fiber Distribution Rack Mount Enclosure

Fiber Distribution Rack Mount Enclosure shall be securely installed where indicated on plans and shall use appropriate mounting hardware. Rack Mount Enclosure shall be mounted in such a way as to provide easy access to components, doors and connection points as mounted within ITS cabinets.

7. Factory Terminated Patch Panel w/ Pigtail

Installation of the Pigtails shall follow manufacturer’s instructions.

8. Junction Box

Junction Box shall be installed where indicated on plans and shall be securely fastened to building using 4 fastening points. Building entrances shall be PVC conduit of a size specified on the plans and shall use weather tight bulkheads on all entrances to the Junction Box. All entrances to building shall be sealed with mastic to prevent water intrusion.

9. 3", 3 Cell Fabric Innerduct

Fabric Innerduct shall be installed from Pull Box to Pull Box or where specified on plans using continuous unspliced lengths. Fabric Innerduct shall be installed using the manufacturers specified installation procedure. After installation, Fabric Innerduct and pull tape shall be secured following the manufacturer’s recommended method.
C. BASIS OF PAYMENT

FIBER SC CONNECTOR; FIBER SC PANEL PIGTAIL; FIBER OPTIC CABLE FUSION SPLICER; FIBER OPTIC CABLE SPLICER ENCLOSURE, ___; FIBER DISTRIBUTION WALL MOUNT ENCLOSURE; FIBER DISTRIBUTION RACK MOUNT ENCLOSURE; FACTORY TERMINATED PATCH PANEL W/PIGTAIL, ____-STEP and JUNCTION BOX, 2’ X 2’ complete, in place and accepted by the City’s Project Manager, shall be measured as a single unit and shall be paid for at the contract unit price bid per each. This price and payment shall be full compensation for furnishing and installing the items; and for all labor, equipment, tools, materials, and incidentals required to complete the Work.

For City of Lincoln furnished items: FIBER SC CONNECTOR, INSTALL; FIBER SC PANEL PIGTAIL, INSTALL; FIBER OPTIC CABLE SPLICER ENCLOSURE, ____; INSTALL; FIBER DISTRIBUTION WALL MOUNT ENCLOSURE, INSTALL; FIBER DISTRIBUTION RACK MOUNT ENCLOSURE, INSTALL and FACTORY TERMINATED PATCH PANEL W/PIGTAIL, ____-STEP; complete, in place and accepted by the City’s Project Manager, shall be measured as a single unit and shall be paid for at the contract unit price bid per each. This price and payment shall be full compensation for installing the items as provided by City of Lincoln; and for all labor, equipment, tools, materials, and incidentals required to complete the Work.

3”, 3 CELL FABRIC INNERDUCT, complete, in place and accepted by the City’s Project Manager, shall be measured as lineal feet from center to center of pull boxes, or where specified on plans, of such material of the size and type require and shall be paid for at the contract unit price bid per linear feet. This price and payment shall be full compensation for furnishing and installing 3”, 3 Cell Fabric Innerduct, pulling tape, all necessary slack, documentation; and for all labor, equipment, tools, materials, and incidentals required to complete the Work.
26.07 INSTALL ITS FIELD SWITCH

A. GENERAL

ITS Field Switch shall be a field-hardened, Ethernet switch provided by the City of Lincoln for installation in cabinet locations as part of Traffic Signal and ITS projects as indicated on the plans.

B. INSTALLATION

ITS Field Switch shall be installed at locations shown on the plans. Unless otherwise specified, the units shall be shelf-mounted in cabinets as indicated, for applicable connections to communications cable and equipment. Switches will be pre-programmed by City of Lincoln, Traffic Operations, with relevant SFP modules for installation. Proper power supplies shall also be installed on din rails, and will be provided by City of Lincoln for contractor installation.

C. BASIS OF PAYMENT

INSTALL ITS FIELD SWITCH, complete, in place, and accepted by the City’s Project Manager, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item only when called for. This price and payment shall be full compensation for picking up and installing ITS Field Switch, all labor, equipment, tools, and incidentals necessary to complete the Work.