

User Guide

National Implementation Construction Guidelines

Audience: Field Ops, OSPE

Version 3.2

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1. Scope

The stated Lumen Outside Plant Construction Standards in this document are the specifications that Lumen and their Vendors/Contractors and Sub Contractors are required to apply during OSP Construction and maintenance projects.

To the extent there is any conflict between these Standards and the Master Services Agreement between Lumen and the Contractor/Vendor, the terms of the Master Services Agreement shall govern.

All the following specifications and requirements for Lumen Outside Plant Workmanship must be called out or included in the Vendor/Contractor's bid form. Thus, the Contractor is expected to price out all specific line item functions and costs that will cover all facets of construction formally stated by the official Scope of Work (SOW) provided in request for pricing via Bidmaster.

This document is NOT an all-inclusive policy and procedure document for OSP Engineers, as there are separate specific documents that cover internal Lumen processes for insuring network integrity in relation to OSP. For additional information on Engineering Standards and Specifications, refer to the Lumen Engineering Standards documentation.

2. Hazardous Materials

When toxic or hazardous materials are encountered in the performance of work, all work in the immediate vicinity of the hazardous material shall be halted and Lumen and the governing authority shall be notified immediately.

Contractor shall be responsible for any and all costs for the removal and corrective measures associated with toxic materials or hazardous materials caused by the Contractor's fault or through its negligence. Contractor will remedy per the governing authority's direction.

3. Existing Utilities

Prior to locates being called in, the Contractor will stake or mark the running line at a maximum of 200' intervals in rural areas and 100' intervals in cities and residential areas with pre-approved color, typically white. Additional staking may be required to identify the running line. All handhole/manhole locations will be staked and/or marked prior to locating.

Contractor shall contact the local buried utilities location service ("State One Call Center" or "Miss Utility") as required by state law. Contractor will contact any utilities not participating in the locate service directly. Notification to owners of existing utilities, at least Seventy-two (72) hours prior to commencing construction, is a must. The Contractor is responsible for documentation, which includes name of company, name of person contacted, date, time, and verification number. If a known utility fails to respond to the locates and is in the area of construction, it is the responsibility of the contractor to contact the State One Call Center or Miss Utility and the utility owner to ensure the locates are completed. Contractor must make all attempts to locate any known existing utilities in the area of construction including potholing where appropriate.

Once potholing is complete, if there is a concern of conflict with an existing utility, contractor should meet with the utility representative in order to resolve said conflicts prior to excavation. A Lumen representative must be notified of this meeting and may elect to be present. If a change in plan is required as a result of the meeting with the utility representative, Lumen must be notified and approve the change prior to construction commencement.

When construction activity will cause the removal of locate markers, digital photographs with date and time stamp will be taken of the markers as well as the paint and chalk marks before and after the activity. Date and time stamped pictures clearly showing the marker post running line (before and after) construction work within the right-of-way (ROW) or easement are recommended whenever possible.

All drawings are generally diagrammatic and not all utilities are included on them. Utilities shown on the construction drawings are located per the best information available. Contractor is responsible for locating all utilities whether on the plans or not. Contractor assumes all liability for any damage to other facilities.

Where existing utilities are present, the Contractor will be responsible for exposing the existing utilities by hand digging (or by vac truck/"soft-dig" methods) prior to working per the local regulatory requirements. Contractor will take every precaution to avoid damage to any underground facility. In the event that the Contractor damages an existing utility, the contractor must know and follow all regulatory requirements as well as contacting a Lumen representative immediately.

The Contractor must verify all locates prior to proceeding with construction of any kind.

4. Damaged Utilities

Any utility damage will be reported to the utility owner and Lumen immediately. This includes any damage to the Lumen cable.

Contractor will cooperate with the owner of the utility to facilitate any repairs necessary.

A copy of all documentation regarding the utility damage shall be submitted to Lumen.

5. Drainage Tile

If underground drainage tile is encountered as facility is placed, the facility should be placed per applicable local drainage district or governing authority specifications.

Any tile lines known to be damaged by Contractor shall be immediately repaired by the Contractor. Permanent tile line repairs will be made within five (5) days of the date the damage occurred, weather and landowner permitting. In case of a dispute regarding the proper repair of damaged tile lines, the repair specifications of the governing authority will be followed.

Repairs made to damaged tile line must enable the tile lines to operate as well or better after the repairs are completed as before they were damaged. Date and time stamped digital pictures of before and after tile repairs are required. Files shall be turned over to Lumen as part of sign off.

Where a tile is damaged, the Contractor must station the location and indicate the location on the red line as-builts.

Prior to backfilling, the contractor must obtain governing authority approval as required.

6. Fencing

6.1 Temporary Fencing

Temporary fencing shall be erected around Contractor's excavations when the excavations are left unattended. Temporary fencing shall meet or exceed the satisfaction of the governing authority. Fencing shall be typical bright orange plastic safety fencing a.k.a. "snow fence."

6.2 Permanent Fencing

In a situation where the contractor has need to cut or remove fencing to obtain access to place or maintain facilities, the Contractor shall obtain written permission from the landowner and/or tenant prior. Any loss incurred due to a failure of adhering to the landowner's requirements will be the responsibility of the contractor.

7. Materials

7.1 Contractor Furnished

Contractor may furnish materials that are identified on the contract drawings and typicals, or as per the Scope of Work that are not specifically called out as being supplied by Lumen.

It will be the responsibility of the Contractor to arrange for his own storage facilities, and delivery of material to and from Lumen warehouses. It is the responsibility of the contractor to verify the receipt of the material. The Contractor will be solely responsible for any materials supplied to them by Lumen once received. Security for the job site areas is the responsibility of the Contractor. Contractor is to comply with the security requirements of owner's site security and other applicable entities.

7.2 Protection of Material

Contractor shall be responsible for protecting finished work, equipment, supplies, and materials from loss, injury, and/or damages from any cause whatsoever until final acceptance by Lumen.

Contractor shall be responsible for the proper care of all Lumen furnished materials, supplies, and equipment while the same are in its custody. Contractor shall account to Lumen for any damage to or loss of such property while in its custody or control. Any remaining project material shall be returned, stored, or disposed of per Lumen's instruction or SOW.

Contractor shall be responsible at all times for protecting the exposed portions of the cable from damage, including intrusion of water. Cable ends will be left at splice locations with sufficient protection to prevent water from entering the cable ends. The Contractor shall replace or repair at Lumen's option, any damage which occurs to the cable as a result of insufficient or improper protection of the cable.

8. Cable Repairs

Damage to the cable which is observed prior to, during or after installation, shall be assessed by a Lumen representative. Determination of the method of correction will be at Lumen's sole discretion.

The damaged section of cable shall be enclosed in: (1) a housing located as specified by Lumen or in (2) a splice enclosure if approved by Lumen. If the shield has been broken or the conductor insulation damaged, the cable shall be restored to the equivalent of new condition. This may require cutting out the damaged section of cable if determined by Lumen representative. It may also require the replacement of an entire section of, or possibly replacing the entire reel of cable.

9. Cable Testing

Contractor assumes all responsibility for the cable upon receipt. This responsibility includes all fibers in the cable, thus it is recommended that the reel be tested by the contractor, at their expense, upon receipt. Any defect must be reported to the Lumen OSPE upon discovery.

At completion of installation, FQA (Fiber Quality Assurance) testing shall be done on the installed cable plant. Overall span and splice loss levels are verified through bi-directional or unidirectional OTDR traces and by light source & power meter testing. This test will also reveal whether fibers were harmed during initial installation. Any defects to the cable, not identified by the contractor prior to installation, will be Contractor's responsibility.

FQA testing requirements, test parameters and instructions are spelled out specifically as per the Lumen FQA process which should be provided by a Lumen representative. (Required Wavelengths, and pulse width recommendations are noted along with uni-directional or bi-directional OTDR traces, depending on the type of installation: i.e. panel to panel span, riser cable, or dark fiber "meet me" cable etc.)

All new OSP fiber cable installed and spliced is to be tested as part of an FQA test package except in cases where new fiber laterals or risers are being spliced into a live system via a "hot cut." In these cases, post installation OTDR testing should be employed to make sure all fibers are acceptable as new and unharmed after their initial installation and validated by a Lumen representative.

10. Depth of Burial

Except where otherwise specified, the cable shall be placed with a minimum of 48" cover for intercity routes and 36" within the Metro area, or as identified in the plan documents unless otherwise approved by a Lumen employee in writing, or permit specifications. Where cable crosses existing sub-surface pipes, cables, or other structures the cable will be placed to maintain a minimum clearance according to the NESC standards or the permitting jurisdiction, whichever is greater. Where cable crosses gullies, ditches, streams, rivers, and washes, the cable will be placed at a minimum depth below the bottom of the waterway according to the Lumen standard regarding metro or intercity routes, unless the controlling authority requires additional depth in which case the greatest depth will be maintained.

11. Cable Warning Tape

The cable warning tape shall be installed above all cable and conduit which is placed by plow or trench. It must be orange and be labeled with "CAUTION, buried fiber below".

The depth of the marking tape shall be as follows:

Place marking tape in soil 12" – 18" above fiber optic in the slot or trench. In situations where it is a slurry trench, the tape should be placed on top of the slurry between the pour and the road base. Another option is to use an orange concrete dye to mark the cable.

12. Manholes, Handholes, Splice Boxes and Pedestals

Manholes or handholes will be placed at all underground splice locations and slack storage locations. Handholes may also be placed at the end of conduit runs or at aerial to underground transition risers to serve as slack storage vaults for the cable. Size, type and placement will be as per the project specific Lumen design drawings. Aggregate bed must be a minimum of 3" or

as per the Lumen drawings, whichever is greater. Structure must sit on top of the aggregate bed.

After placing the vault (whether handhole or manhole as per design), Contractor shall backfill to a level even with the top of the vault or as specified per the drawings or permit requirements, and the Contractor shall complete backfill and tamping of vault pit in accordance with the drawings and within Trenching Section of these Specifications.

In some circumstances, pedestals will be required at splice locations or as indicated on the constructions drawings. The need and location of pedestals will be determined by Lumen or the governing authority.

When pedestals are required, contractor will place one HDPE duct between the handhole and the pedestal. Contractor shall place one ground wire from the pedestal to the handhole for each cable end in the handhole, leaving a 30-foot coil of each in the handhole. The ground wires shall be terminated to the ground lug in the pedestal. Contractor shall mount pedestals to a signpost with a warning sign or per requirements.

A ground rod shall be placed in all manholes, handholes, splice boxes and standalone pedestals. Pedestals that are placed next to a vault must have a ground wire installed from the ground rod to the ground lug in the pedestal.

13. Plowing

13.1 General

The equipment and construction methods used by the Contractor shall be such as to cause minimum displacement of the soil.

Damage to banks, ditches, driveways, and roads caused by the equipment shall be immediately repaired, at contractor's expense, to the satisfaction of Lumen, property owner, and public authorities having jurisdiction.

Where cable is buried near the edge of pavements, the Contractor shall take particular care to avoid damaging the pavement. If such damage occurs, repair shall be made immediately, at the contractor's expense, to the complete satisfaction of state or local authorities having jurisdiction over the pavement.

13.2 Pre-ripping Requirements

Pre-ripping, where required, shall precede plowing and shall be made in the same direction as conduit is to be plowed at a depth of 4" greater than the minimum conduit depth required.

13.3 Plowing Equipment Requirements

The plow tractor and pull tractor, if required, shall be capable of maintaining the specified cover and prevent damage to the conduit. Under certain soil conditions, it is likely that a pull tractor shall be required. Any additional equipment that is necessary to accomplish the plowing operation shall be at the discretion and expense of the Contractor.

The plowing equipment shall be subject to the approval of Lumen and the public authorities having jurisdiction over the right-of-way.

13.4 Plowing Requirements

The slot made in the soil by the plowshare shall be closed immediately and compacted as per permitting authority specifications.

Ends of casings and crossings of foreign utilities shall be exposed prior to start of plowing operations. Care is to be exercised during the plowing operation to feed the conduit into the ground through the plow, loose and at no tension. Equipment and construction methods shall be such as to assure compliance with this requirement.

The Contractor shall furnish competent supervision at all times at the site of plowing operations to assure compliance with this requirement.

13.5 Plowing in Rock Areas

Soil conditions shall be defined and documented as rock when field conditions at the site show the existence of rock at a depth preventing the placement of conduit at the depths required.

The equipment used during rock excavation shall be designed or suitable for digging in the specific type of rock encountered. Compensation for rock excavation shall be applicable as detailed in the scope of work. Any additional compensation for rock excavation must be approved by a Lumen employee in writing.

14. Trenching

14.1 Excavation

When trenching to place conduit, the trench will be the minimum reasonable width to place the conduit per the scope of work. The conduit trench shall be as straight as practicable. The bottom of the trench shall be smooth and free from any sharp edges. The trench shall be kept clear of debris and loose rock. All changes in trench grade shall be gradual as to not cause a bend in the conduit which will cause excessive friction during cable placement. In general, the vertical change in grade shall not exceed 1' in 3' (1:3) of cable. **When trenching to place Metro conduit, the trench will be a minimum 36" of cover, while intercity conduit will be a minimum 48" of cover unless otherwise stated in statement of work or permitting authority requirements.**

Open trench shall be closed at the end of the day unless there are extenuating circumstances preventing the closure. In such cases, any open trench shall be fenced or plated. Exceptions are subject to approval by Lumen, in any areas where the governing authority's rules are more stringent, those rules will supersede the trenching guidelines given by Lumen. Good judgment and care must be exercised to prevent livestock or persons from falling into the open trench.

Driveways, lanes, or roadways, which are open cut, shall be opened just prior to the conduit placing. In no case shall the driveway, lane, or roadway be left impassable at the end of the day. The general public safety is paramount and appropriate steps shall be taken to ensure safety at all times. Where a drive or roadway must be left open for traffic, the Contractor must provide the material and method required to allow for movement of traffic. In no instance shall a single entrance or exit be blocked to prevent traffic from entering or exiting a residence or business without discussions with the owner or resident of the premises.

It is the contractor's responsibility to ensure the security and safety of all materials on the worksite.

14.2 Backfill

The trench shall be backfilled and compacted to the satisfaction of Lumen and local authorities, promptly behind the conduit placing, except at splice locations. In general, the backfill shall consist of appropriate material free of rock and debris 2" or greater.

When a carrier, pipe, conduit, or duct is placed by trenched construction beneath a roadway or a driveway or within five feet of the edge of an existing or proposed pavement or base course, the backfill within the roadway shall be placed and compacted per the governing authority specifications.

In areas inaccessible to tamping type rollers where compaction is required, a mechanical tamper of a size suitable for the work involved shall be used.

Pneumatic tampers shall be operated at pressures no less than those recommended by the manufacturer.

Compaction of backfill shall be to the satisfaction of Lumen and the permitting authority and warranted as per the Master Services Agreement, and consistent with good roadway construction methods.

14.3 Trenched Road and Driveway

It is preferable to bore all hard-surfaced areas. The backfill at crossings of driveways, lanes, or roadways shall be as required by governing authority.

Hard surface replacement shall be restored to original condition or better. Hard surface repair shall be subject to approval by Lumen and must conform to the requirements of the local governing authority having jurisdiction including required cutbacks. Hard surface repair not installed in accordance with the requirements of these Specifications shall be removed and replaced at the Contractor's expense.

14.4 Trench in Rock

See the *Plowing Section* for a definition of rock.

Compensation for rock excavation shall be applicable as detailed in the scope of work. Any additional compensation for rock excavation must be approved by a Lumen employee in writing.

Where solid rock is encountered, the trench may be excavated using a rock saw or other rock cutting equipment. The excavation, backfill, and road crossings in solid rock areas shall conform to all Specifications detailed throughout unless specifically exempted in this Section. All construction in rock must be pre-approved by Lumen.

14.5 Rock Removal

If rocks are excavated from a trench, bore pit, or other excavation, the Contractor will backfill the excavation with appropriate material free of rock and debris 2" or greater.

If rocks are removed from any backfill material, they will be hauled away from the landowner's property by the Contractor.

15. Directional Boring

15.1 Duct Placement

The running line of the duct shall be kept as straight and level as possible. Any changes, either vertical or horizontal, shall be gradual.

Adequate barricades shall be erected to limit access to the boring machine to operating personnel only.

Contractor shall calibrate the boring head locator at the start of the day and at each new boring operation. A daily calibration log shall be kept for review by Lumen personnel.

Upon completion of duct installation, duct continuity will be proofed via a method to be pre-approved and may be observed by Lumen. Failure to gain pre-approval may result in Contractor being required to reproof the duct.

Bore profiles shall be recorded at the time of boring to comply with the Lumen as built CAD standards and should be noted on field drawings/red-lines for inclusion on permanent final "As-built" drawings

15.2 Backfill

The bore pits and potholes shall be backfilled and compacted to the satisfaction of Lumen and the governing authority promptly behind the pipe placement, except at pipe access locations. In general, the backfill shall consist of appropriate material free of rock and debris 2" or greater.

Pneumatic tampers shall be operated at pressures no less than those recommended by the manufacturer.

On public right-of-way all back-filling must conform to the requirements of the authority having jurisdiction.

If rocks are removed from any backfill material, they will be hauled from the landowner's property by the Contractor.

16. Bridge and Fixed Structure Attachments

16.1 General

This practice describes methods for the placement of Lumen conduit and fiber optic cable onto bridges and fixed structures. In this context, a fixed structure is defined as a tunnel, wall or other permanent surface to which Lumen will attach conduits, cables, devices or support structures.

When placing conduit inside bridge cells, federal, state, county and city requirements for attachment to the structure and seismic requirements for the bridge and conduits and cables should be reviewed with a qualified engineer.

Unless more stringent requirements are made by the permitting authority, Lumen approved conduit materials for attachment to bridges and fixed structures are:

- Galvanized Rigid Conduit (GRC)
- Split or Slotted Galvanized Steel Pipe (SPGSP)
- Bullet Resistant Fiberglass (with Lumen approval)

- High Density Polyethylene (HDPE)

Conduit will not be attached to draw, swing or other type of movable bridges or structures. Conduit will not be attached to wooden bridges or structures unless no alternative placement method is available.

Approval for attachment to wooden bridges or structures must be obtained in writing from the appropriate Lumen representative and the structure owner.

Handholes will be placed at both ends of bridge at which locations a transition from the conduit used to cross the bridge to HDPE will be made.

All attachment brackets will be hot-dipped galvanized.

Design must include vibration-dampening materials for easing vibration stress caused by rail or road traffic. Neoprene insulators or equivalent will have a minimum of one-quarter inch (1/4") thickness. Welding to a metal bridge or structure is not allowed unless otherwise approved in writing by the appropriate Lumen representative and the permitting agency / structure owner.

All nuts (top cone lock-nuts, side-lock nuts or equivalent), bolts and lock washers will be of stainless steel or hot-dipped galvanized design. Neoprene vibration insulators will be used in assembly. When embedding bracket studs in concrete, an epoxy cartridge will be used.

Attachment brackets will be placed to adequately support the conduit structure. A general guideline would be attachment at optimum intervals of ten feet (10'). Bracket spacing to fifteen feet (15') may be allowed in special cases. A length equal to one diameter of the bolt will be exposed after nut is in place.

The design of bridge attachments shall minimize bends and to the greatest possible extent shall maintain a horizontally and vertically straight conduit alignment. If there are expansion joints in the bridge design, a conduit coupler that allows for expansion or an attachment that allows for conduit movement should be utilized.

Bridge attachments will be placed as high on the structure as practical, but always above the bottom of the bridge.

Extend all bridge conduit a minimum distance of twenty feet (20') beyond the structure at each end unless design shows otherwise.

Concrete Bridges are generally sound structures for bridge attachments. Typically, there will be sufficient structure area on which to place brackets.

Generally, head walls may be core bored if required upon approval by the permitting authority. However, the core bore must not cut any rebar. The core bore must be sleeved with Schedule 40 GSP/GRC and concrete grouted. Link Seal inserts may be used in lieu GSP/GRC and grout, if approved by the owner of the structure.

17. Duct and Innerduct Installation

17.1 Duct and "Innerduct" Installation

Before installing Lumen innerducts that are within a casing pipe, rodding, roping, cleaning, and verifying existing casing pipe may be required. Before placement, the leading edge of each duct/innerduct shall be sealed. Upon completion of placement, the duct/innerduct shall rest freely in the conduit and splice boxes or manholes without tension and spare innerducts shall be capped with standard fitting duct caps or plugs.

17.2 Locate Wire

In areas where a di-electric cable will be placed in a newly placed duct or in situations where duct only is being placed, the Contractor must place in the trench or bore hole a continuous #10 AWG locate wire. If placing di-electric cable into an existing duct, the locate wire should be pulled into the conduit with the cable. The locate wire must be terminated to a ground lug as per applicable or as-designed in the Engineering drawings.

18. Underground Cable Installation

Cable will not be cut/spliced at pipe or other crossings or anywhere else solely for the convenience of installation. As required, the cable shall be removed from the reel by approved methods," to be installed through the pipe crossings or under other utilities. Splice locations are to be placed as per design/engineering drawings and the direction of Lumen representative for future network access at key locations. Splices on spans must be kept to a minimum (as per design) to prevent excessive signal loss (especially on Long Haul network).

18.1 Cable Pulling

The optical fiber cable provides high capacity transmission channels. To ensure that the cable's qualities and characteristics are not degraded, excessive pulling tensions or excessively short bending radii should be avoided. Safe handling of the cable using the figure eight method at transition points is the required method of placement. The maximum pulling tension is 600 lbs. and the minimum bending radius should follow the manufacture's specifications. These rules should be followed at all times.

Lumen reserves the right to have Contractor test pulling equipment prior to any cable placement. When pulling fiber, a break-away swivel, along with a Slip Clutch Capstan Winch that shows the dynamometer reading at all times shall be used.

Industry approved cable lubrication shall be used as needed during the cable placement operation. At each splice location a minimum of 65' of cable will be left on each cable end for splicing, or as indicated on the construction drawings. The cable ends will be sealed water-tight at all times to keep water from entering the cable.

At no time shall any reels be unmanned during cable installation.

18.2 Cable Jetting (Blowing)

Jetting is one of the most efficient and safest means of installing fiber optic cable into an underground duct system. Proper preparation is imperative to cable blowing to allow for faster placement. Prior to beginning installation of cable, duct integrity needs to be established. The duct must also be free of obstructions allowing the cable to move freely during the blowing process.

For installation, the appropriate size parachute must be chosen to ensure the ability of the air to "push" the cable through the duct. A silicone based, cable blowing lubricant should be used to ease movement of the parachute through the duct.

The appropriate pushing force from a hydraulic powered tractor is also important to provide cable slack as well as reducing back tension. This allows the cable to remain loose and flexible reducing friction and resistance. Safe handling of the cable using the figure eight method at transition points is the required method of placement.

18.3 Micro-milling

Micro-milling or APICAL is another method of placement that may at times be required. Specific specifications for Micro-trenching will be provided with the construction drawings if this method is chosen for placement.

19. Major Underground Crossings

19.1 Roadway Crossings

When crossing a limited access highway or RRs, in no case shall the completed crossing be less than 48" deep at its shallowest point or as required by local governing authority. If the pipe casing bored under the roadway exits below the prescribed depth, a backhoe or equivalent will be used to gradually return the bored ditch to plowed grade.

All crossings shall exit at toe slope or beyond unless otherwise indicated on the drawings.

19.2 Waterway Crossings

Waterway crossings shall be installed and restored in accordance with the Typical Drawings and the applicable Construction Drawings and the respective Federal, State, and Local agencies, including those agencies concerned with water pollution and the protection of sport fisheries. The cable is to be installed in accordance with depth burial requirements outlined within these Specifications

The Contractor shall restore the banks of all waterways to their former condition and install bank protection materials or bulkheads where required. The methods of restoration and erosion control shall be as required by the landowners or agency having jurisdiction and as approved by Lumen. Banks will be reseeded and mulched with grass seed and mulching material as required by local governing authority. Berms will be constructed, where practicable, to divert water away from the trench line and disturbed bank areas.

As nearly as possible, the beds of all waterways shall be restored to their former elevation and grade, and soil, debris, piling, cofferdams, false work, excavation, construction materials and obstructions resulting from installation of the cable shall be removed from the crossing to prevent interference with normal water flow and interference with any normal use of waterways and shall be disposed of in a manner and at locations satisfactory to Lumen. Underwater spoil shall be spread to a height not to exceed 6" above the bed of waterways.

Contractor shall not begin work on waterway crossings before obtaining approval from Lumen. It is the intent of these specifications to require Contractor to install the cable underneath the bed of the waterway at such a depth that shall prevent flood water from affecting the cable by abrasive scouring action of tides or flowing muddy water, etc. Particular attention shall be given to the location of sag bends in the cable so that they shall be located back in the waterway beyond any point that would be affected by a change due to erosion of the banks.

Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing in the conduct of the work. Unless specified otherwise at individual stream crossings, the Contractor shall be required to:

Grade banks of stream crossings by pulling the spoil back from the bank. Contractor shall not push spoil out into the stream to grade the approaches.

Refrain from the use of cofferdams or from diverting the stream in any way in order to construct a stream crossing.

20. Aerial Cable

20.1 General

This practice describes procedures and precautions for aerial fiber cable installation.

Personnel involved in placing aerial fiber optic cable will be familiar with standard practices, precautions and the manufacturer's specifications.

At reel ends, the Contractor shall hang 100-foot coils of each cable on the strand, unless more is needed for splicing due to location, unless otherwise directed by Lumen. After the splicing is complete the splice case will be hung and grounded and the coils will be lashed per the typical drawing. If the splice case needs to be moved, the Contractor shall replace the grounds if removed.

20.2 Precautions

All N.E.S.C. Codes will be met when working on aerial plant.

Care will be taken to avoid cable damage during handling and placing. Avoid sharp bends and take precautions to prevent any damage to cable during placement. Such damage may alter the transmission characteristics to the extent that the cable section will have to be replaced.

When pulling fiber cable, the proper device must be used to prevent exceeding maximum tensile strength of the cable per manufacturer standards.

It is the contractor's responsibility to know, understand and not exceed the maximum pulling tension and the minimum bending radius of the cable per the manufacturer's specifications.

The obtaining of all locates involved with the ground rod placement and anchor placement is the sole responsibility of the Contractor.

All cable reels or exposed cable need to be secured in a safe environment.

Risers will be placed per the Lumen Standard Pole Riser Detail. See Appendix A

At no time will newly installed fiber optic cable be cut at locations not specified within the engineered drawings without prior approval of the Lumen representative. Where cable is cut the cable ends will be sealed water-tight to keep water from entering the cable.

20.3 Aerial Cable Placement

All hardware must be new and shall be subject to Lumen approval.

Strand will be placed as specified on the construction drawings.

Pre-lashing of cable to strand will not be allowed.

At no time shall any reels be unsecure.

Cable will have a 4" to 6" drip loop and fiber warning tag at every pole. Tags will contain Lumen identification as required.

Cable will be dual lashed with a 45mil stainless steel lashing wire unless otherwise specified by Lumen.

Slack Coils are to be dual lashed or housed in a snow shoe per typical drawings. This includes slack coils at splice locations after the splicing has been completed.

Strand will be grounded per NESC standards. At a minimum, Strand will be grounded at ¼ mile intervals with #6 copper wire bonded to power company MGN/MGNV (if permissible) or to a 10-foot long copper clad ¾" ground rod.

All anchors must be placed before strand and guy installation begins.

The size, type, and location of anchors are shown on the construction drawings and typicals. If there are no anchors shown on the drawings and an anchor needs to be placed, please contact your Lumen Engineer. Two situations where anchors should be placed are at dead ends and where there is a change of direction of more than 4'. Other field conditions may also require anchoring.

U-Guards must conform to placement per Appendix A.

Preformed wraps will be used for all suspension strand dead ends, splices and both ends of guy wires. Tree trimming (3' minimum window or as required by the permitting authority, whichever is greater) will be the responsibility of the Contractor. Contact all property owners before trimming. Note: Licensing and special permitting may be required for this activity. It is the contractor's responsibility to know the regulations for tree trimming in the area and secure the appropriate approvals.

20.4 Sag and Tension

Strand tension will not exceed sixty percent (60%) of the strand breaking strength under storm load conditions.

Cable blocks/cable roller will be spaced at a maximum interval of thirty-five feet (35'). Contractor is required to provide sufficient blocks and pull-line.

Minimum 6.6M ¼" EHS minimum suspension strand will be used and tensioned to proper sag unless otherwise specified on work drawings.

All strand and cable installation shall be in accordance with NESC codes and Power Company rules and regulations. The Contractor is responsible to report to Lumen any problems or violations immediately.

20.5 Guying

All guys will be built using ¼" EHS strand minimum unless otherwise specified on work drawings. Guy guards are to be placed on all down guys or as required by the pole owner.

All corner poles will be guyed where the change in direction exceeds 4'.

20.6 Clearance

Aerial plant clearance requirements are based on the National Electric Safety Code (N.E.S.C.) and shall meet all requirements of the governing authority and pole owner.

The cable is classified as a fiber optic supply cable as described in the N.E.S.C.

21. Building Specifications

The specifications in this section are pertinent to work that is done on the exterior or interior of a building. The building could be owned by Lumen or another entity. The contractor is responsible for obtaining their own COI for each building when required.

21.1 Installation Requirements

The complete conduit system, work, materials and installation, included under the specification and as indicated on the drawings shall be in strict accordance with and conform to all current Local, State, UL (United Laboratories) and National Electrical Code, as well as all other rules, regulations, ordinances of any organization, company or authority having jurisdiction.

The Contractor is responsible to ensure that other utilities that exist on the private property are located or proper precautions are taken when the locates are not completed.

The Contractor is responsible to coordinate all activities with the building owner/manager and other utilities as appropriate.

Accompanying and forming a part of these Specifications are design drawings which are generally diagrammatic. They indicate the approximate location of conduit, pulls, boxes, hangers, and penetrations. Any changes will be pre-approved by Lumen prior to work. Such changes will be noted on as-built drawings submitted to Lumen.

All materials throughout this installation shall be new and the best of their respective kind. Materials shall be installed in a neat, accurate, and competent manner.

Conduit shall be of high quality and match the size indicated on the design drawings. All hangers, fittings, and rods shall be malleable steel either UL, NEMA, or ANSI approved. All hangers, fittings, and rods shall be hot-dipped galvanized steel where subject to corrosion.

Use of one-hole straps with back plates, J-hangers, clevis or Unistrut type trapeze are the only acceptable hangers for the installation of GIP Conduit with approval of Lumen.

Where GIP (Galvanized Iron Pipe) conduit is used, all hangers, rods, and other hardware shall also be hot-dipped galvanized.

Use of aluminum conduit hangers or factory plastic coated steel hangers are the only acceptable hanger for installation of aluminum EMT or rigid aluminum conduit.

All conduit, whether it is EMT or innerduct shall be labeled a minimum of every 20' and at every junction box with Lumen labels.

21.2 Conduit, Hangers, Pull Boxes

Contractors shall install the conduit system as detailed on the drawings. The installation must include additional incidental pull boxes, hangers, and/or expansion joints required to complete a professional, permanent condition even if the total number of hangers, joints, etc., were not called out on the design drawings. Bending radius on all conduit shall be a minimum 18" unless otherwise specified on the drawings or approved by Lumen. Contractor shall place string/jet lines in each conduit and/or innerduct installed.

Contractor shall seal all cores and penetrations in an acceptable and competent manner as soon as the work is completed to prevent leakage. Repairs should match existing facilities.

Contractor shall replace at its sole expense, any ceiling tiles damaged during installation.

21.3 Cleanup

Contractor is responsible to keep clean and dispose of all debris from the work area at the end of each workday and upon completion of the Work.

Contractor is bound by the base specifications of the building the work is being performed in.

21.4 Firestopping

Firestopping guidelines for Lumen can be found in Chapter 4 of the Lumen Telecommunications Equipment Installation Guidelines.

22. Cable Identification Markers

22.1 Minimum Requirements

The Contractor should have cable identification marking supplies in the quantity applicable to ensure signage standards are met. The Contractor can purchase these supplies with the current Lumen supplier.

Rural route should have marker posts, soil marker or curb markers placed every 1000 feet (or within line of sight) and at road intersections/changes to the route direction.

Metro route should have marker posts, soil marker or curb markers placed every 500 feet (or within line of sight) and at road intersections/changes to the route direction.

All routes must have signage that identifies not only the presence of the Lumen facilities, but to also give a general view of the location and direction of the cable. Signs must be placed according to the following criteria:

- Recommendation that sign spacing is at least every 1000 feet in rural areas and every 500 feet in urban areas. Although the type of geographical area and line of sight will be better indicators for signage placement.
- At each side of a road crossing, railroad crossing, intersection and water crossings
- At the corners of turns in the cable where there is a change in direction or significant offsets
- At all hand-holes and splice locations (except on paved streets and sidewalks in city environments)
- Signage is also to be placed in logical locations for building entrances and any other location where a transition needs to be identified.
- All OSP signage must be in compliance with local, DOT and/or jurisdiction requirements. These requirements will vary across each jurisdiction. Always check with jurisdiction to determine proper placement.
- Individual OSP identification markers should be placed as close to the actual underground facilities as reasonably possible with allowance to avoid traffic hazards. Exact location of marker and distance from the underground cable/conduit running line should be recorded in field notes and transcribed to the permanent As-built drawings.
- In situations where the snow cover could cover the above ground appurtenance, a snow marker should be used to mark facilities above the snow line.
- All cable must also have either wrap around markers or stenciling identifying it as Lumen cable in every vault, manhole, pole riser, building entry, etc.

22.2 Underground

In manholes and handholes it is necessary to identify Lumen cables. Lumen will use either self-laminate cable tags or a wraparound style labels to identify cables. The standardized Lumen cable tags can be purchased through the Lumen supplier.

Tag placement recommendations:

- Within twelve inches of cable entrance/exit into the manhole/hand-hole.
- At the center of any sack coil locations.
- Within twelve inches of the endplate of a splice enclosure (for all cables).

- At any other locations where fiber identification is necessary or would be beneficial for protection and identification.

22.3 Buildings

In all buildings it is necessary to identify Lumen facilities. Self-laminate cable tags, wraparound style cable marker or the Lumen caution sticker can be used to identify cables, conduits and pull boxes within a building.

Tag placement recommendations:

- At the building entrance within twelve inches of entrance.
- Every 25 feet of horizontal cable or flex duct run (steel conduit may require a sticker).
- On each floor of vertical run (preferably one near the floor and one near the ceiling if traversing a large room).
- Every 25 feet above a drop ceiling or a horizontal chase way.
- Within twelve inches of the fiber entering a suite or equipment room.

22.4 Aerial Cable

In an aerial environment is necessary to identify Lumen cable facilities and splice cases. As an overall standard there must be cable tag on all riser poles. Self-laminate cable tags, wraparound style cable marker or the Lumen caution sticker can be used. Certain pole owners may require specific signage. Refer to the engineering drawings for the specifics.

Tag placement recommendations:

- Within twelve inches above the top of a cable guard or the top of the conduit on riser poles.
- Within twelve inches of the end of the eyebolt at dead-ends.
- Around the cable beneath the three-bolt clamp at through poles.
- Within twelve inches of the pole attachments at crossovers, turns, or transitions.
- On each side of slack loops and one marker at the approximate center-point of the slack loop.
- Within twelve inches of the endplate of a splice closure.

23. Right-of-way Protection and Restoration

23.1 General

The Contractor shall protect the right-of-way and minimize the damage from construction operations.

Good soil erosion practices shall be practiced during all construction operations.

Depending on the location of the Work, the Federal Environmental Protection Agency, the State Environmental Protection Agency or others may stipulate construction practices and crew's behavior requirements in or around environmentally sensitive areas, such as cultural resource sites. Contractor shall adhere to any such stipulated construction practices and crew behavior requirements.

23.2 Restoration

The Contractor will repair any soil conservation systems (such as terraces, grassed waterways, etc.) which are damaged by the cable's installation. All soil conservation systems shall be restored to their pre-construction condition or better.

23.3 Removal of Construction Debris

The Contractor will remove from any affected properties private or public all cable installation debris and materials which was not there before the cable installation commenced and which is not an integral part of the cable system. (NOTE: Such material to be removed would also include litter generated by the construction crews). The Contractor is responsible for the proper disposal of all soil, concrete, asphalt or other debris. Pavement shall be removed per Lumen standards and the governing authority. An environmentally approved disposal site must be secured and used by the Contractor. All disposal fees are the responsibility of the Contractor.

The Contractor will work with landowners to prevent or correct excessive erosion on all land disturbed by construction by implementing reasonable methods to control erosion.

If the landowner or property owner and Contractor cannot agree upon a reasonable method to control erosion on the landowner's right-of-way, the Contractor will follow the recommendations of the appropriate Soil and Water Conservation District.

Contractor shall keep the premises where work is being performed in a neat, clean, and orderly condition.

The right-of-way shall be restored to its original or better condition as facilities are placed or as soon as practicable, in Lumen's opinion, following placing operations.

Where the cable is plowed in place, restoration shall be accomplished by driving a tractor over the plow furrow until the plowed area conforms to the surrounding terrain. Appropriate compaction density must be obtained. A vibratory roller may also be used.

In areas where open trench methods were used and backfill mounded over the trench, grading or filling will be required for final restoration of the right-of-way. Original compaction density must be maintained or exceeded during final restoration.

All rock and debris brought to the surface and left after backfilling shall be removed and disposed of, as directed by Lumen.

All areas disturbed by the construction activities in public right-of-way shall be restored and reseeded per the specifications of the governing authority. In areas of improved landscape, lawns, shrubs, and hedges removed or damaged shall be repaired to like or better condition. Any mulching of reseeded areas or sodding of disturbed areas shall be per the specifications of the governing authority.

Examples where the permit may specify a different vegetative program may be in areas involving natural prairie grasses where a different mixture of seedlings may be required or in highly erosive areas where additional erosion control measures may be required.

All restoration shall be completed as soon as cable placing operations are completed in these areas, or at the direction and per the specifications for seeding as determined by the governing authority's representative.

Stumps, trees, limbs, and brush shall be removed and disposed of appropriately.

All terraces which were removed or damaged shall be replaced to original or better condition as soon as feasible, in Lumen's opinion, following cable placing operations.

The Contractor shall promptly repair or replace any other property damaged during construction.

24. Traffic Control

It is the responsibility of the vendor to ensure that the appropriate traffic control setup is performed at any location where applicable based on governing authority regulations and/or danger to workers or general public is present. All barricades and/or warning devices must be setup in a manner that conforms with the most stringent of (i) the most recent issue of MUTCD and (ii) federal, state, or local laws, rules or regulations.

All traffic control devices must be in good repair. Barricade warning lights and/or reflective devices shall be provided on any equipment used during hours of darkness.

All traffic control devices must be picked up at the conclusion of the work.

25. Permitting/Easement

It is the responsibility of the vendor to ensure the appropriate permit or easement has been approved for any work that is done in or around a public ROW or private property. The vendor must maintain a copy of the permit at the site of the work being done at all times.

Whenever any work is performed within 50 feet of railroad tracks or upon a railroad right-of-way, a Railroad Protective Liability Insurance policy may be required by the railroad. If required, the vendor will have such policy issued in the name of the railroad with such limits as required by the railroad for bodily injury, property damage, or physical damage to the property. This insurance policy will be in form and substance satisfactory to the railroad and will be delivered to and approved by the railroad prior to the entry upon or use of the railroad property.

26. Emergency Repairs

Emergency Repairs are urgent, time critical measures taken to restore services when damage occurs to Lumen OSP Fiber Network and Infrastructure. Whether damage is from severe weather events, animal damage, or man-made, the goal at these events is to get the fiber plant "out of harm's way" and restore service/traffic carrying capability as fast as possible while maintaining safety for both the physical network and the public.

Multiple Lumen OSP Vendors/Contractors/Subcontractor may be called out for an immediate response to such emergency repairs to achieve the fastest restoration. Required response time to these emergencies is reflected in the Master Services Agreement.

Temporary measures can be taken at the discretion of the Lumen representative in order to meet our stringent restoration timeframe. Temporary measures must still meet the requirements of keeping our fiber "out of harm's way" and not endangering public or personal property. Permanent repairs must then be made shortly after the emergency has passed.

All permanent repairs must meet the same OSP construction standards as covered throughout this document for Underground or Aerial OSP installation as applicable.

Permanent repairs are meant to restore the Lumen OSP fiber and infrastructure to same or better condition as before the damages occurred.

27. Relocates

Lumen relocations are tightly managed by a Centralized Relocations team. All relocation work must conform to the drawings provided. Any deviation must be approved by a Lumen OSPE prior to making the change. Any requests by the permitting authority or contractor on the site

must be referred to the Lumen OSPE unless otherwise dictated during the project kick off meeting.

27.1 Splices Related to Relocation Work

The number of splices on a span shall not be increased as a result of a relocation unless prior approval is provided by a Lumen representative. The replacement cable shall extend from existing splice points. In some cases, there is no available optical budget to compensate for additional loss due to splicing.

28. As-built Drawings

As-Built drawings are to-scale drafted sectional drawings that map sections of fiber optic cable routes. They illustrate how a section of a route has been built and how it has been placed.

For each section of the Lumen fiber optic network, there are at least three sectional drawings including:

- Preliminary
- Construction Red Line
- As-Built

Each of these sets of drawings represents its associated section of the route at three different stages:

- The Preliminary drawing depicts the design of a given route.
- The Construction drawing functions for a section of cable route as a blueprint does for the construction; it includes changes, known as red lines, which reflect the revisions that take place in the section from the time of its design through its actual construction.
- The As-Built drawing represents the section of cable route after it has been constructed. The drawing combines the information in the Preliminary drawing, the Construction drawing, and field revisions to provide an up-to-date map and blueprint of a working section of a route of Lumen's fiber optic network.

28.1 Redline Requirements

Existing Conduit Utilized

- Sequential numbers at the end of innerducts for slack coils (2 numbers).
- Reel numbers and sequential numbers at the end of innerducts and the end of cables at splice locations (4 numbers).
- Accurate dimensions between structures if there is a deviation from the construction drawings.
- The size and number of HDPE used (i.e. (3) 1" HDPE, (1) 1¼" HDPE, etc.).
- Verification of duct assignments.
- GPS Coordinates may also be requested depending on the type of project.

Aerial Construction Utilized:

- Sequential numbers at every pole.
- Reel numbers are to be identified at the start and end locations. The "red line" drawings shall identify the date installation was performed and the foreman in charge of that segment of work.
- The size and position of any aerial slack spans (sequential number at beginning and end of slack coil).

- Attachment height, mid span height, road crossing and driveway lowest height.
- Position and placement of new anchors, guys, lead, size, etc.
- Sequential number at top and bottom of pole at riser locations.
- Show all bonds to existing verticals and all new verticals placed.
- GPS Coordinates may also be requested depending on the type of project.

New Underground Placement:

- Sequential numbers at the end of innerducts for slack coils (2 numbers).
- Reel numbers are to be identified at the start and end locations. The “red line” drawings shall identify the date installation was performed and the foreman in charge of that segment of Work.
- Sequential numbers at the edges of the handhole and the end of the cables (4 numbers).
- Accurate depths, most notably if the cable deviates from the required depth, as specified in plan documents.
- Accurate dimensions of the route off of hard objects such as roads, poles, right-of-way markers, etc.
- Stations and sequential numbers for the beginning and ending of all bores along with the size and number of duct used.
- Station numbers at every warning sign location.
- GPS Coordinates may also be requested depending on the type of project.

29. References

| Name | Link | Description |
|--|---|--|
| National Implementation Engineering Guidelines | https://portals.level3.com/sites/GFS/DocumentStore/L5UG_National_Implementation_Engineering_Guidelines.docx | OSP/ISP Engineering Guidelines |
| AutoCAD Setup Instructions Manual | https://portals.level3.com/sites/GFS/DocumentStore/AutoCAD%20Setup%20Instructions%20Manual.docx | AC Template Setup Instructions |
| Detail Drawing Standards Manual | https://portals.level3.com/sites/GFS/DocumentStore/Detail%20Drawing%20Standards%20Manual.docx | AC Drafting Standards |
| LISP Reference Manual | https://portals.level3.com/sites/GFS/DocumentStore/LISP%20Programs%20Reference%20Manual.docx | List of LISP References |
| Template Master Unit List | https://portals.level3.com/sites/GFS/DocumentStore/NEWCO%20Template%20Master%20-%20NAT%2008-20-2018.xlsx | List of Engineering and Construction Units |

30. Version History

The latest version of this document can be found at:

https://portals.level3.com/sites/GFS/DocumentStore/L5UG_National_Implementation_Construction_Guidelines.docx

Electronic copies in any location other than the Document Store, plus all printed copies, are uncontrolled.

| Version | Date Published | Business Process Owner (Region) | Document Writer | Summary Of Changes |
|---------|----------------|---|--------------------|------------------------------------|
| 1.0 | 7/18/18 | Joe Meissner, Rick Cook, Gabe Schnelle, Gary Pace, Nancy Servantez, Bruce Carney, Rick Jurosky, John Nagel, Jon Ellingson | Veronica McClinton | First Release |
| 2.0 | 8/28/18 | Rick Cook, Bill Chandler | Veronica McClinton | Added Appendix A |
| 3.0 | 9/26/18 | Heather Seabury | Veronica McClinton | Added Reference Table |
| 3.1 | 01/03/20 | | Andrea Llamzon | Updated to new CTL Word template |
| 3.2 | 09/22/20 | | Andrea Llamzon | Updated to Lumen logo and verbiage |

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