Attachment D - Standards for Fiber Deployment (Existing / New)

References, Standards, and Codes

Standards are based upon the *Customer-Owned Outside Plant Design Manual* (CO-OSP) produced by BICSI, the *Telecommunications Distribution Methods Manual* (TDMM) also produced by BICSI, ANSI/TIA/EIA and ISO/IEC standards, and NEC codes, among others.

It is required that the Designer be thoroughly familiar with the content and intent of these references, standards, and codes and that the Designer be capable of applying the content and intent of these references, standards, and codes to all outside plant communications system designs executed on the behalf of District.

Listed in the table below are references, standards, and codes applicable to outside plant communications systems design. If questions arise as to which reference, standard, or code should apply in a given situation, the more stringent shall prevail. As each of these documents are modified over time, the latest edition and addenda to each of these documents is considered to be definitive.

Table 1 — References, Standards, and Codes

Standard/Reference	Name/Description
BICSI CO-OSP	BICSI Customer-Owned Outside Plant Design Manual
BICSI TDMM	BICSI Telecommunications Distribution Methods Manual
BICSI TCIM	BICSI Telecommunications Cabling Installation Manual
TIA/EIA – 758	Customer-Owned Outside Plant Telecommunications Cabling Standard
TIA/EIA – 568	Commercial Building Telecommunications Cabling Standard
TIA/EIA – 569	Commercial Building Standard for Telecommunication Pathways and Spaces
TIA/EIA – 606	The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TIA/EIA – 607	Commercial Building Grounding and Bonding Requirements for Telecommunications
TIA/EIA - 455	Fiber Optic Test Standards
TIA/EIA - 526	Optical Fiber Systems Test Procedures
IEEE 802.3 (series)	Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard
NEC	National Electric Code, NFPA
NESC	National Electrical Safety Code, IEEE
OSHA Codes	Occupational Safety and Health Administration, Code of Federal Regulations (CFR) Parts 1910 - General Industry, and 1926 - Construction Industry, et al.

This section defines design considerations for outside plant communications media (cable and connecting hardware) that are of particular concern to District. The Designer is expected to refer to the TIA/EIA standards and the BICSI CO-OSP and TDMM for other and more specific design criteria and detail.

Additional Considerations

Unsatisfactory Operations: Should it be necessary to halt the work because of incorrect or unsatisfactory operations under the terms of the awarded contract or because of failure to follow safety standards applicable hereto, the Respondents must take immediate steps to remedy the deficiencies. Should repair or correction of any safety defect or deficiency not be immediately undertaken, and should the District be required to protect the site or make the repair or correction, the cost of such work shall be deducted from payment due the Respondent.

Inspection: During any inspection including, but not limited to, the final inspection of each work site, should it be found that non-concealed work is substandard, the burden of proof that the concealed work is up to standard shall be the Respondent's, who shall do such as is necessary, including exposing the concealed work, to clearly establish that the concealed work meets the specifications as outlined. Any and all items such as, but not limited to, improperly set couplings and concrete or masonry work that is not up to specified standards shall be removed and replaced at the Respondent's expense.

General Design Considerations

Material Requirements

1. Material will comply with those standards as established by UL or NEMA and shall be commercial grade. All Materials will be new and free from defects.
2. Bidder to provide and install in all conduit raceways MaxCell 3" - 3 Cell innerduct Part# MXD3456BK5300 or equivalent.
3. Last Mile specifications - Bidder will place two (2) - 4 in PVC schedule 40 / Rigid Conduit (Underground feeds / directional boring) HDPE in the ground and/or two (2) 4 in EMT into the building (In the ceiling to Hub Location. (Work to meet and or exceed NEC code). EMT fitting shall be gland or set screw type, and each conduit shall be equipped with a graduated pull tape or mule tape. The exact requirements for location of conduit within the building shall be verified with building owner.
4. Bidder will place one (1) - 4" Conduit at all crossings. (PVC-80, Rigid, IMC or better with innerduct and a pull rope / Mule tape).
5. Large-radius sweeps shall be provided where required for offset or change in direction of conduit. The minimum radius recommended in 36" and the minimum radius acceptable is 24". If it is not possible to provide 24" minimum radius sweeps, pull boxes providing the same radii capacity will be required.
6. Generic Fiber Cable Part Numbers: AFL SM Fiber. The Fiber to Range from ADSS 12F design code: DNA-32643 to 96F Design code: DNA-32638 or equivalent.
7. Fiber (individual strand) specifications. Possible specifications include:
    a. Single Mode
    b. ITU-T G.652.C/D compliant or better
    c. Zero water peak single-mode fiber
    d. Maximum Attenuation @ 1310nm 0.34 dB/km
    e. Maximum Attenuation @ 1385nm 0.31 dB/km
    f. Maximum Attenuation @ 1550nm 0.22 dB/km
8. Fiber optic *cable* specifications. 12 Strand minimum, but if funding is available larger fiber may be cable may be placed.

9. Bidders pulling hand-hole, a 35' coil of fiber will be left coiled in the bottom of the box. At each splice location, 75' will be left on each cable end for splicing. Tags will be placed on fiber showing the direction of the cable. The cable ends will be sealed watertight to keep water from entering cable.
10. Bidders will include transport connectivity by placing an add/drop location (Hand Holes with 75' splice loop) eligible entities which may include colleges, universities, state government, tribal, and K-12 institution buildings.
11. Must become a member of NM811, Call before you dig. Comply with agreement and mapping.
    a. http://www.nm811.org/wp-content/uploads/2013/03/FD108MembershipApplication.pdf

A **PRE-SURVEY:**

Comply with all ordinances and regulations. Where required, secure permits before placing, excavating on private property, crossing streams, pushing pipe or boring under streets and railways. Pre-survey shall be done prior to each job.

B **PERMITS:**

The contractor must adhere to all applicable laws, rules and requirements and must apply for permits to place infrastructure per specification per county or city ordinance applicable to where the infrastructure is being placed.

TRAFFIC CONTROL

All traffic control, in accordance with local, state, county, or permitting agency laws, regulations, and requirements, will be the contractor's responsibility. The Contractor's construction schedule will take into consideration sufficient time for the development and approval of a traffic control plan.

Traffic control will include flagmen, signs, arrow-boards, two-way radios, cones, and other appropriate equipment where required.

All restricted work hours will be observed: for example, 9 am to 3 pm means work operations will begin at 9 am and crews and equipment will be off the right-of-way at 3 pm with no unsafe conditions at the site.

Sufficient lights, lighted barricades, arrow-boards, and reflective vests for flagmen will be used in night work operations.

Two-way radio communications will be maintained at all times during traffic control operations.

C **LOCATES**

Contractor will locate underground lines of third parties in cable route area. Contractor will call the "NM 811 Dig" System or appropriate alternative prior to the any work commencements. Contractor will directly contact any utilities not participating in the NM 811 Dig System if there are markers. Determine all locates of existing underground structures. Contractor will responsible for private locates for any existing utilities for schools.

D **TRACER WIRE INSTALLATION**

1. Tracer wire shall be placed with all HDPE conduit installed unless armored or traceable cable is used. The Contractor will provide the tracer wire and shall install, splice and test (for continuity) the tracer wire. If the tracer wire is not placed or is broken during installation, the Contractor shall notify the APS Project Manager immediately. The area of the route that does not have the tracer wire installed shall be identified on the as-built documents submitted by the Contractor.

2. For multi-duct installation, install a 5/8" X 8" copper clad ground rod in the hand-hole located on public right-of-way. Place a #12 insulated copper locate wire from the ground rod to the fiber optic termination room or to the outside of the building directly below the pull box and terminate on one side of an insulated indoor/outdoor terminal block to the master ground bar in the fiber optic termination room or place a ground rod on the outside of the building. Locate block in an accessible location. This is for "locate purposed only," not for grounding purposes. Note on as-built where ground is placed and tag located wire as "locate wire."

E **DEPTH OF BURIAL**

1. Except where otherwise specified, the cable shall be placed to a minimum depth of 36 inches unless otherwise approved by the APS Project Manager. Greater cable depth will be required at the following locations.

2. Where cable route crosses roads, the cable shall be placed at a minimum depth of 48" below the pavement or 36" below the parallel drainage ditch, whichever is greater, unless the controlling authority required additional depth, in which case the greatest depth will be maintained.

3. Where the cable route crosses railroad right-of-way, the cable shall be placed at a minimum depth of 60" below the railroad surface or 36" below the parallel drainage ditch, whichever is greater, unless the controlling authority requires additional depth, in which case the greatest depth will be maintained.

4. Where cable crosses existing sub-surface pipes, cables, or other structures: at foreign object crossings, the cable will be placed to maintain a minimum of 12" clearance from the object or the minimum clearance required by the object's owner, whichever is greater.

F **HIGHWAY, RAILROAD AND OTHER BORED CROSSINGS**

1. All crossings of state or federal highways and railroads right-of-way shall adhere to state and federal requirements. Country road and other roadways shall be bored, trenched, or plowed as directed by the APS Project manager and approved by the appropriate local authority.

2. All work performed on public right-of-way or railroad right-of-way shall be done in accordance with requirements and regulations of the authority having jurisdiction there under.

3. Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the Work as drawn.

G **CABLE MARKERS**

1. Cable markers shall be placed within 48 hours of cable installation. Cable markers shall be placed at all change in directions, splices, fence line crossings, at road and stream crossings, and other points on the route not more than 1,000 feet apart.

2. In addition, on highway (non-freeway) right-of-way, the markers shall be located at the highway right-of-way line. Markers shall always be located so that they can be seen from the location of the cable.

H **CONDUIT/INNERDUCT DESIGN**

1. Determine whether the selected duct, as indicated on the running line sheet or plan, has a mule tape or pull rope within it. Preferred innerduct: MaxCell 3" - 3 Cell innerduct Part# MXD3456BK5300 or equivalent.

A **HAND HOLES**

1. Hand holes will be traffic rated and placed in accordance with standard industry practices. Excavate as required to firm, undisturbed soil for laying conduit. In the case of hand-hole/manholes, excavate six (6") below bottom of structure and fill with six (6") inches of ¾" of river rock.

2. All due caution will be exercised in transporting and off-loading hand holes to prevent any damage during shipping or placement. Any damage to hand holes after their initial receipt and inspection by the Contractor will be the sole responsibility of the Contractor, who will replace such damaged hand holes at no additional expense to the State of New Mexico.

3. Immediately after placement, the soil around the hand hole will be tamped and compacted. The compaction will be performed using a mechanical tamping/compacting machine to avoid wash-outs. Should any wash-outs occur, the Contractor will be responsible for correcting the problem immediately without additional cost to the State of New Mexico.

4. After cable placement all ducts will be sealed.

2. AERIAL PLANT

1. Maintain clearances which are dependent on the NESC, state, municipality, and/or local company practices shall govern the actual requirements.

   a. **Vertical Clearances:** Maintain clearance per ***"BICSI OSP Telecommunication Standards."***

   b. **Horizontal Clearances:** Maintain clearance per *"BICSI OSP Telecommunication Standards"*

Comment [JR1]: Adjust this to meet our requirments

2. Where a pole supports more than one suspension strand, each strand should be guyed separately.

3. A strand will be a minimum of 6M, unless specified by pole drawings.

4. All corner poles should be guyed where the pull is greater than 3 feet.

3. AERIAL SPANS:

1. Span lengths are limited by the following factors: Strand tension shall not exceed 60 percent of the breaking strength under storm loading conditions. Sag shall not exceed 10 feet at 60 degree Fahrenheit with no wind. The 6.6M strand tension shall not exceed 1400 pounds.

2. MANHOLES

1. splice hand holes/manholes will be grounded

2. One 5/8-inch x 8-foot copper-clad steel ground rod equipped with a 15-foot #6 AWG Pigtail

K. **AERIAL CABLE GROUNDING**

1. Cable sheath to strand bonds and grounding are required at all riser locations of an aerial segment.

2. Bond cable sheath and suspension strand to multiground neutral (MGN) vertical grounding conductor if one exists; if not, use a driven ground rod or a non-insulated guy.

3. A guy may also require grounding. This is determined by establishing the exposure status (exposed or unexposed) of the guy.

4. All exposed guys must be either grounded or insulated. A guy is exposed if it is attached to the same pole as open power conductors or spacer cable of any voltage.

5. Grounding is the preferred treatment for exposed guys, except for the following cases in which they must be insulated:

The guy fastened to the pole in Power Company working space and a grounded guy would offer an additional hazard to power company lineman. Within 1/2-mile of a power station.

Where electrolytic corrosion of anchors has occurred (unexposed guys, in this case, must be separated from the cable strand at the pole, and electrical connection through hardware must be avoided).

Adequate grounding for guys may be obtained through connection to any of the following:

Vertical grounding conductor of power system multiground neutral (with permission of the power company).

Common anchor rod with a power guy that is connected to the multigrounded neutral.

6. Unexposed guys need not be grounded for protection reasons; however, connecting anchor guys to a grounded strand is recommended, as it will lower the cable-to-ground impedance. This helps to reduce cable damage caused by lightning.

L. **TESTING CABLE**

1. The Contractor/Subcontractor shall be responsible for on-reel verification of cable quality prior to placement.
2. Completed test forms on each reel shall be submitted to the APS Project Manager.
3. Contractor assumes responsibility for the cable after testing. This responsibility covers all fibers in the cable.
4. The Contractor shall supply all tools, test equipment, consumables, and incidentals necessary to perform quality testing.
5. The cable ends shall be sealed upon completion of testing.

M. **FIBER SPLICING**

1. All splices shall be placed in hand-holes. There are to be no direct buried splices.
    a. Cable and closure preparation shall conform to the manufacturer's standards and installation manual
2. All fibers are to be spliced according to the splice assignment sheets provided by (Applicant).
3. All fibers are to be fusion spliced and placed in Raychem FOSC 450 fiber optic gel enclosure or equivalent according to the manufacture technical installation instructions.
4. All spliced fibers shall be protected by using the appropriate organizer tray and associated incidental items.
5. To insure acceptable splices prior to closing and encapsulating the splice case, Contractor shall monitor the splice while it is being performed using and OTDR or a splicer with some type of optimizing capability, such as a LID unit or an optimizing alignment screen or equivalent.
6. Splice grounds
    a. A number six insulated ground wire shall be installed from the pedestal through existing conduit to the splice enclosure and terminated at both ends.
    b. The ground wire at the pedestal shall be identified with major direction associated with the running line of each of the links within a Span.
    c. Contractor must verify that all fibers are compatible end to end fiber, i.e., fiber number 12 at location A is fiber number 12 at location Z.
7. Loss Specifications

a. The maximum acceptable loss for the cable shall be .35dB/km @1310 nm and .25dB/km @ 1550nm.

b. The maximum acceptable loss per splice shall be:

- Maximum splice loss in one direction shall be .2 dB.
- Maximum bi-directional average splice loss shall be .2 dB.
- Maintenance splice loss Allocation. At acceptance, each fiber shall have sufficient reserve loss margin to accept the loss associated with six (6) future maintenance splices and still meet the Span unallocated gain margin.

N. **RESTORATION**

1. All work sites will be restored to as near their original undisturbed condition as possible, all cleanup will be to the satisfaction of the State of New Mexico, any permitting agencies.

2. Work site restoration will include the placement of seed, mulch, sod, water, gravel, soil, sand, and all other materials as warranted.

3. Backfill material will consist of clean fill. Backfilling, tamping, and compaction will be performed to the satisfaction of the State of New Mexico, the representative of any interested permitting agency, and/or the railroad representative.

4. Excess material will be disposed of properly.

5. Debris from clearing operations will be properly disposed of by the contractors as required by permitting agencies or the railroad. Railroad ties, trees, stumps or any foreign debris will be removed, stacked, or disposed of by the contractor as per requirements by other interested permitting agencies, and/or the State of New Mexico.

6. All cleanups will be conducted on a daily basis.

7. Road shoulders, roadbeds, and railroad property will be dressed up at the end of each day. No payment for installation will be permitted until cleanup has been completed to the satisfaction of the any permitting agencies, and/or the State of New Mexico.

8. Work will not proceed until cleanup is complete.

9. Site clean-up will include the restoration of all concrete, asphalt, or other paving materials to the satisfaction of the other interested permitting agencies, and/or the State of New Mexico.

O. **SAFETY**

The State of New Mexico is dedicated to providing its employees with safe and healthful working environments as well as equipment, materials, and training required for the safe completion of assigned tasks. The same commitment is required from all contractors, subcontractors, and material suppliers.

The latest editions of the following codes and regulations define the minimum safety and construction standards required by State of New Mexico.

National Electrical Manufacturer's Association (NEMA)

Code of Federal Regulations, Title 29, Occupational Safety and Health Standards (OSHA)

National Electrical Code (NFPA No. 70)

Underwriters Laboratories, Inc.

Lightning Protection Code (ANSI-5. l)

Applicable Local, State, and County Ordinances

All protection equipment will satisfy the appropriate OSHA, ANSI, and/or MIOSH standards.

OSHA regulations require that precautions be observed to avoid cave-ins when digging boring pits and trenches, especially under wet soil conditions. This is a matter of law and safety.

All contractors are required to abide by applicable regulations of the Occupational Safety and Health Administration (OSHA) Act of 1970 (any subsequent revisions). Each contractor must provide employees with all safety equipment required by OSHA, The State of New Mexico and the various governing agencies. Questions regarding compliance with the various regulating agencies will be the responsibility of the Safety Director of each contract company.

Safety rules cannot be inclusive. Workmen must refrain from unsafe and improper practices including both the violation of written rules and regulations and of unwritten **rules of "common sense."**

The construction contractor must ensure his employees and subcontract employees are familiar with, and are in compliance with, all appropriate regulations and codes, such as OSHA Safety and Health Standards of the U.S. Department of Labor.

FF. **DOCUMENTATION**

1. As Built Drawing will include:

   a. Fiber Cable Route

   b. Drawings, site drawings, permit drawings, and computerize design maps and electronically stored consolidated field notes for the entire route must be included in the documentation. The method of installation will dictate the additional types of documentation that should be provided. For example, documentation of aerial installation should include pole attachment inventories, pole attachment applications, pole attachment agreements between contractor and other utilities, GPS points of reference for utility poles, and photo images of poles to which fiber is attached. Documentation of underground installation should include conduit design, conduit detailing (Identify location of existing plant in relation to edge of pavement, road or structure), manhole detailing, preparation of all forms and documentation for approval of conduit construction and/or installation, verification of as-built and computerized maps.

   c. Splicing locations

d. Optical Fiber assignments at Patch Panels Optical fiber assignments as splice locations. (All labeled)

e. Installed cable length

f. Date of Installation

2. Fiber Optic details will include:

a. Manufacturer

b. Cable Type, Diameter

c. Jacket Type: Single Mode

d. Fiber core and cladding diameter

e. Fiber attenuation per Kilometer

f. Fiber bandwidth and dispersion

3. OTDR Requirements and documentation will include:

Final acceptance shall be contingent upon successful end-to-end testing of each terminated fiber strand to validate the optical performance of the entire link, as well as to verify that fiber splicing and installation of optical splitters has occurred according to supplied splice matrices. This testing will consist of bi-directional OTDR testing and power meter testing between each newly connected site and its corresponding hub. This testing shall occur only after fibers are terminated at both ends of a continuous link, and all intermediate construction and/or splicing involving the re-entry of installed splice cases or handling of the fiber optic cable is completed for a particular segment under test.

The Respondent shall provide the District with electronic documentation of all test results.

A. *Testing Criteria:* Testing shall be deemed successfully completed if: (1) maximum fiber losses meet manufacturer specifications, with an allowance for splices and connectors; (2) individual splice losses do not exceed 0.1 dB; and (3) maximum mated connector losses do not exceed manufacturer specifications. Testing will be performed by Respondent personnel, and may be observed by designated representatives of the District. The District may request and/or perform additional testing to verify results prior to accepting test data.
B. *OTDR Testing Procedure:* An OTDR shall be used to measure and document splice losses and connector losses. To correctly identify abnormalities at a short range, a 100-meter or longer launch cable shall be used between the OTDR and the fiber under test. Bi-directional traces shall be acquired for each fiber. If the connection of the launch cable to the patch panel requires optimization by the operator, sampling acquisition will commence upon completion of the optimization.
C. Each fiber will be identified, and the results of the test for each fiber will be recorded as indicated below in the section “Test Data File Names.” The test will be repeated for each of the fibers linking a particular site. All tests will be made at 1310 nm and 1550 nm.

   Settings on the OTDR shall reflect the following:

i. The Refractive Index shall be set for the actual fiber utilized (commonly-used Corning SMF-28 single mode fiber has a refractive index of 1.4677 at 1310 nm);
ii. Pulse width no greater than 100 ns (10m) for all fiber lengths;
iii. Scattering coefficient specified by the fiber manufacturer for each wavelength tested;
iv. A minimum of 10,000 sampling acquisitions (averages);
v. Maximum range set to no more than 10 km for all fiber length less than 10 km;
vi. Maximum range set to no more than 25 km for fiber lengths greater than 10 km; and
vii. Event threshold: 0.05 dB

A uniform file-naming scheme for recorded data shall be used, complying with the following conventions or mutually agreed conventions by the District and Respondent.

The file name shall be in the format "xxx000yyy111," where:

- xxx = site name or splice location (Sp1, Sp2, etc.) at which the OTDR is located (see table below)
- 000 = three digit fiber port number (or fiber strand number for un-terminated fiber)
- xxx = site name or splice location (Sp1, Sp2, etc.) at the opposite end from where the OTDR is located (see table below)
- 111 = three digit fiber port number (or fiber strand number for un-terminated fiber)

For example, ParkES002PEG048.trc would be the OTDR trace captured from Park Elementary School to fiber port 48 at the PEG Center. The filename PEG048ParkES002.trc would be for the OTDR trace captured on this same fiber in the opposite direction.

Installed optical fiber OTDR test documentation shall include:

i. Total fiber length;
ii. Individual fiber traces for complete fiber length;
iii. Losses of individual splices and connectors;
iv. Losses of other anomalies;
v. Wavelength tested and measurement directions;
vi. Manufacturer, model and serial number of the test equipment; and
vii. Name and company of the technician performing the tests.

All data collected at each location during the tests shall be recorded at the time of the tests using electronic means.

4. Optical Power Meter Requirements and Test Procedure: Optical power meter measurements shall be made at the same time as the OTDR tests to determine overall fiber loss and to ensure that fibers have appropriate end-to-end continuity (fibers not crossed, connector bulkhead in the proper panel position, etc.). Power meter testing shall be performed at both 1310 nm and 1550 nm and shall report the relative loss of each fiber strand.

Power Meter documentation will include:

a. Total link loss of each fiber

b. Wavelengths tested and measurement directions

c. Manufacturer, model, and serial number of test equipment

d. Date of last calibration.