FACILITIES MANAGEMENT AND OPERATIONS CENTER

FMOC

Specification Section 16750 Intrabuilding Telecommunications

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This document has undergone formal review and approval and been reviewed by a Derivative Classifier and its contents have been deemed unclassified/unlimited release.

Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Change Log

Rev. No.	Changed By	Date	Change Description	Pages Changed
0	KC/EB/KLB	11/18/11	Per SMEs this specification replaces 16742. Applied FMOC brand and formatting. Edited for grammar, punctuation, and general writing improvements. Incorporated comments and revisions supplied by reviewers.	
1	SM/LEO	7/2/12	Incorporated changes per Shaun Martin's request.(F. Red Data bullet 2a) (C. Worst-case test values 1b)	

Part 1 - General

1.01 Summary

A. Section 16750 covers all products, tools, consumables, and test equipment needed to complete the project described in the Statement of Work. Some products might be Sandia National Laboratories, New Mexico (SNL/NM)-furnished material (SFM) as noted in the contract documents and on the drawings for executing interbuilding and intrabuilding telecommunication cabling both for new construction and remodeling projects at SNL/NM. The specification is addressed to the contractor selected to perform such work at SNL/NM. All work must be performed as described in this specification, on SNL/NM-supplied drawings, and in the contract documents.

1.02 Definitions and Acronyms

A. Definitions of Cabling Systems

Term	Definition
Interbuilding Cable	Telecommunication cable between buildings.
Intrabuilding Cable	Telecommunication cable within a building.
TE Connectivity®	Provides network infrastructure products and services for high-speed internet, video, data, and voice services. Formerly Audio Development Company (ADC). This manufacture's materials, certifications, and warranty are required for the installation of the BLACK GPON intrabuilding data system.
CommScope® and SYSTIMAX® Technologies	A company that certifies telecommunication personnel and equipment in the United States. This manufacturer's materials, certifications, and warranty are required for the installation of all outside plant fiber, intrabuilding voice copper cabling, and intrabuilding RED data systems at SNL/NM.
Superior Essex®	A manufacture of outside plant copper communications cable for interbuilding telephone or voice system at SNL/NM.

B. GPON Topology

1. Passive optical networks are made of fiber optic cabling, passive splitters, couplers, jumpers and other related components. These components distribute an optical signal through a branched tree topology to connectors that terminate each fiber segment. The following are the three topologies at SNL/NM:

   a. Legacy buildings: Where the existing BLACK user outlet contains CommScope® single-mode fiber. The fiber is fusion-spliced in the intermediate distribution room (IDR) and terminated with STII+ single-mode connector at the BLACK user outlet. A single-mode jumper is installed from the outlet to the ONT. The following buildings have legacy single-mode fiber: 810, 821, 823, 836, 870, 890, 891, 897, 905 and 962.

   b. Zone-cabling: Cabling that distributes from horizontal cross-connect to office/lab area using a consolidation point (RDT) serving optical network terminals (ONTs) within that zone. This method is used in larger buildings.

   c. Home Run: A method of distributing a direct fiber from a fiber splitter box (FSB) to an ONT. A FSB is used in a smaller building where the fiber distribution hub (FDH) would be larger than needed

C. Acronyms

AC	Alternating Current
ADC	Audio Development Company
APC	Angle Physical Contact – Angle Polish Connector
ANSI	American National Standards Institute
AWG	American Wire Gauge
BICSI	Building Industry Consulting Service International
CAT	Category, Cable Type
C	Centigrade
CDIN	Classified Distributive Information Network
DOE	United States Department of Energy
DOEM	United States Department of Energy Telecommunications Security Manual
dB	Decibel
dBm	Decibel Milliwatt
EIA	Electronic Industry Alliance
ELFEXT	Equal Level Far-End Cross Talk
EMI	Electrical Magnetic Interference
EMT	Electrical Metallic conduit
ES&H	Environmental, Safety, and Health
ETPR	Extended Thermplastic Rubber
GPON	Gigabit Passive Optical Network
FDH	Fiber Distribution Hub
FSB	Fiber Splitter Box
ft	feet
ICEA	Insulated Cable Engineers Association
IDR	Intermediate Distribution Room
IMC	Intermediate Metallic Conduit
ISDN	Integrated Services Digital Network
km	Kilometer

LC	Little Connector, Fiber Optic Connector
LIU	Lightguide Interconnection Unit
LRL	Link Return Loss
MDC	Main Distribution Center
MDR	Main Distribution Room
mm	Millimeter
MM	Multimode Optical Fiber
MPO	Multifiber-Push On
MTP	Multiple Termination, Push-pull Latch Fiber Optic Connector
NEC	National Electrical Code
NEXT	Near-End Cross Talk
NFPA	National Fire Protection Association
NNSA	National Nuclear Security Administration
nm	Nanometer
NM	New Mexico
NVP	Nominal Velocity of Propagation
OF	Optical Fiber
OM-4	Optical Mode 4
ONT	Optical Network Terminal
ORL	Optical Return Loss
OSHA	Occupational Safety and Health Administration
OSP	Outside Plant
OTDR	Optical Time-Domain Reflector
PTS	Protected Transmission Systems
PSNEXT	Power Sum Near End Cross Talk
PSELFXT	Power Sum Equal Level Far-End Cross Talk
RJ-45	Registered Jack, 8-pin Modular Connector

RDT	Rapid Distribution Terminal
SC	Subscriber Connector, Fiber Optic Connector
SCN	Sandia Classified Network
SDR	Sandia-Delegated Representative
SFM	Sandia-Furnished Material
SM	Single-mode Optical Fiber
SNL/NM	Sandia National Laboratories New Mexico
SOC	System Operation Center
SON	Sandia Open Network
SRN	Sandia Restricted Network
ST	Straight Tip, Fiber Optic Connector
TDMM	Telecommunication Distribution Methods Manual
TIA	Telecommunications Industry Association
TIEG	Telecommunications Infrastructure Engineering Group
UL	Underwriters Laboratory
UTP	Unshielded Twisted Pair

1.03 References

The most current editions of the following standards are part of this specification:

A. **Electronics Industry Alliance/Telecommunications Industry Association.** Commercial Building Telecommunications Cabling Standard [ANSI/TIA/EIA], http://www.tiaonline.org.

B. **United States Department of Energy Telecommunications Security Manual,** [currently DOE M205-1-3 April 17, 2006]. The Department of Energy has mandated that this manual will not be available to contractors, but it can be viewed at SNL/NM by making an appointment with the SNL/NM Protected Transmission Systems (PTS) Coordinator representatives through the Systems Operations Center (SOC) at (505) 844-8670.

1) The project may contain RED [Sandia Classified Network (SCN)], BLACK [Sandia Restricted Network (SRN)], Sandia Open Network (SON), or telephone systems.

RED (classified) systems require special security procedures. Contact Systems Operation Center (SOC) at (505) 844-8670 to request the PTS Coordinator representatives for information supplementing this specification. Personnel performing installation, maintenance, or modification of a Classified Distributive Information Network (CDIN) must be Q-cleared. Technically qualified L-cleared or uncleared persons may perform such work provided they remain under constant visual

observation and supervision of a technically qualified Q-cleared person.

C. **SNL/NM CDIN Plan.** This document will not be available to contractors, but it can be viewed at SNL/NM by making an appointment with the SNL/NM PTS Coordinator representatives through the Systems Operations Center (SOC) at (505) 844-8670.

D. **SNL/NM Transmission Security Checklist.** This document will not be available to contractors, but it can be viewed at SNL/NM by making an appointment with the SNL/NM PTS Coordinator representatives through the Systems Operations Center (SOC) at (505) 844-8670.

E. Building Industry Consulting Service International (BICSI) (http://www.bicsi.org).

a. Telecommunications Distribution Methods Manual (TDMM), current edition.

F. SNL Construction Standard Specifications and Drawings

Number	Title
Section 01065	ES&H for Construction Contracts
Section 01330	Submittal Procedures
Section 01700	Contract Closeout
Section 02584	Underground Ducts and Utility Structures
Section 05500	Metal Fabrications
Section 07270	Firestopping
Section 09900	Painting
Section 16001	Electrical Work
Section 16440	Electrical Panelboards
Section 16725	Access Control System
T1001STD	Communications IDR Layout and Details
T-5001STD	Communications Details
T-5002STD	Communications Red Use Outlet Details
T-5003STD	IDR Label Details
T-5004STD	IDR Label Details
T-6001STD	Equipment Schedule, Legend, and Abbreviations
T-9001STD	Typical Backbone Raceway System, Black
T-9002STD	Typical Backbone Raceway System, Red

G. **SNL/NM supplies drawings that show the interbuilding and intrabuilding cable system.** They provide the location of intermediate distribution rooms (IDR), RDT locations, user outlets, rack frame, and cabinet locations. The RED and BLACK GPON data systems will be fiber only. The telephone system will be UTP copper.

1.04 Submittals

A. Submit a site inspection report as described in section 3.01.

B. Provide manufacturer's data for specified materials not listed in the SNL/NM Standard Drawings Telecommunications Equipment Schedule T-6001STD.

C. Quality Control Documentation

1. Procedures: Before beginning construction, provide the following items to the Telecommunication SNL/NM Designated Representative (SDR):
   a. Written, detailed procedures including techniques for securing, protecting, and dressing transitions from optical fiber (OF) cable to connector.
   b. A written company quality control policy including measures to be taken throughout the contract to ensure delivery of quality work to SNL/NM.
2. Contractor Qualifications for the installation of intrabuilding GPON BLACK data systems: Before beginning construction, provide to the Telecommunications Infrastructure Engineering Group (TIEG) certification of installers meeting quality assurance requirements and include the following items:
   a. Proof that all personnel installing or performing telecommunications work have a minimum status of a BICSI Installer 2 certification for the media being installed.
   b. TE Connectivity badge of good standing as Authorized Installer status for SNL/NM for BLACK GPON data systems.
3. Contractor Qualifications for the installation of interbuilding RED and BLACK outside plant fiber: Before beginning construction, provide to the TIEG certification of installers meeting quality assurance requirements and include the following:
   a. Proof that all personnel installing or performing telecommunication work have a minimum status of a BICSI Installer 2 certification for the media being installed.
   b. CommScope badge of good standing as Technologies Authorized Installer status for interbuilding outside plant fiber.
   c. CommScope Technologies training certifications of all onsite personnel for interbuilding outside plant fiber.
4. Contractor Qualifications for the installation of intrabuilding voice copper cabling: Before beginning construction, provide to the TIEG certification of installers meeting quality assurance requirements and include the following:
   a. Proof that all personnel installing or performing telecommunication work have a minimum status of a BICSI Installer 2 certification for the media being installed.
   b. CommScope badge of good standing as Technologies Authorized Installer status for intrabuilding voice copper cabling.
   c. CommScope Technologies training certifications of all onsite personnel for intrabuilding voice copper cabling.
5. Contractor Qualifications for the installation of intrabuilding RED data systems: Before beginning construction, provide to the TIEG certification of installers meeting quality assurance requirements and include the following items:
   a. Proof that all personnel installing or performing telecommunication work have a minimum status of a BICSI Installer 2 certification for the media being installed.

b. CommScope badge of good standing as Technologies Authorized Installer status for intrabuilding RED fiber.

c. CommScope Technologies training certifications of all onsite personnel for intrabuilding RED fiber.

d. Personnel performing installation, maintenance, or modification of a CDIN must be Q-cleared. Technically qualified L-cleared or uncleared persons may perform such work provided they remain under constant visual observation and supervision of a technically qualified Q-cleared person.

e. Proof that all personnel testing RED optical fiber have Fluke Certified Cabling Test Technician certification.

6. Contractor must submit documentation showing that the test equipment to be used is calibrated to the manufacturer's specification.

Training Requirements	OSP Copper	OSP Fiber	OSP Fiber	VOICE	GPON	RED DATA
	BLACK	RED	BLACK	BLACK	BLACK	RED
BiCSi Installer 2 Copper & Fiber	X	X	X	X	X	X
TE Connectivity					X	
CommScope		X	X	X		X
Q-Clearance		X				X
Fluke Testing		X	X	X		X

Figure 1.1 Contractor Qualification Checklist

Note: Personnel performing installation, maintenance, or modification of a CDIN must be Q-cleared. Technically qualified L-cleared or uncleared persons may perform such work provided they remain under constant visual observation and supervision of a technically qualified Q-cleared person.

D. Warranty

1. TE Connectivity Warranty

   a. A written statement is required guaranteeing performance of the entire installation of the BLACK GPON system for a minimum period of 25 years, starting from the day of acceptance. This 25 year TE Connectivity warranty must be delivered to the TIEG within 30 days of completion of project.

2. CommScope Warranty

   a. A written statement is required guaranteeing performance of the entire installation of interbuilding outside plant fiber, intrabuilding voice copper cabling, and intrabuilding RED fiber data systems for a minimum period of 20 years, starting from the day of acceptance. This 20 year CommScope warranty must be delivered to the TIEG within 30 days of completion of project.

   b. If other items supplied as part of the project have warranties that will last less than one year after the project's final acceptance, supply a full parts and labor warranty for a year after acceptance.

E. Detailed Drawings for New Design and Design-Build Construction Projects

1. These detailed drawings must be submitted and approved by SNL/NM TIEG for all projects before construction begins and must follow SNL/NM Telecommunications Systems Design Guide.

F. Progress Reports on Testing

1. For all tests performed, submit to the TIEG electronic files within a week of performing the test.
2. Progressive submittals on a weekly basis are required for large-scale tests lasting more than one week.

G. Final Reports on Testing

1. Submit final electronic test data using manufacturer's tester specific software (i.e. Link Ware) confirming that cabling has been tested according to SNL/NM requirements. This is due to SNL/NM one week after completing the installation.
2. All electronic cable charts and test reports must be sent to IEG@sandia.gov.

H. Final Cable Charts

1. Supply an electronic copy of the cable charts for RED data and voice cabling to the TIEG and provide one hard copy of the final reports for each intermediate distribution room (IDR) and each main distribution room (MDR) or main distribution center (MDC).
2. The electronic copy must be in Microsoft® Excel format and labeled with the test date, building number, contractor's name, and the contract or job number.
3. File names must always start with RED for classified or BLACK for unclassified systems, followed by the user outlet number.

I. Submitting Final Testing and Cable Charts

1. All test data and cable charts must be sent electronically to IEG@sandia.gov

2. Different types (BLACK, RED, GPON, or VOICE) of cable charts or test results should be in separate Excel spread sheets and files, one for the BLACK drops, one for the RED drops, one for the GPON drops, one for the Voice, outside plant (OSP), and so on.

For GPON:

1) Request an electronic Excel file from the TIEG representative on the project.
    a. The Contractor must request the current chart from the database.
    b. Enter required data in Excel file.
2) Return files via email with the following completed:

a. Send multiple entries for a building as one request
b. Text in the email should have the following:
    i. Count of how may entries were changed on each FDH
    ii. What was done; for example:
        1. Added three entries on FDH 01
        2. Changed 5 entries on FDH 02
    iii. Format the email message as shown in Figure 1.2.

```
BUILDING DATA IS FOR BLDG-XXX

DATE

BLDG-# XXX
BOX-# GPON- XXXXX, XXXXX, XXXXX, XXXXX, and XXXXX
TYPE – GPON
FDH 01 - added XXX entries, removed X comments
FDH 02 – added X entries, removed X comments, changed X bldg #s

BLDG-# XXX
BOX-# VOICE- XXXXX, XXXXX, XXXXX, XXXXX, and XXXXX
TYPE – VOICE

BLDG-# XXX
BOX-# RED-XXXXX, XXXXX, XXXXX, XXXXX, and XXXXX
TYPE – RED

BLDG-# TO XXX BLDG-# FROM XXX
TYPE – OSP (RED or BLACK)
```

Figure 1.2 Sample Email Format for GPON Message

J. As-Built Drawings

1. Prepare as-built documentation and provide it to the Telecommunications SDR at project completion. The Facilities Engineering SDR will provide assistance in obtaining one set of reference drawings.
2. An electronic file must be submitted to the TIEG at the end of the project.

Part 2 - Products

2.01 General

A. Ensure that all products (any installed products or materials such as cabling, outlet boxes, and connectors) meet the requirements of NFPA 70 [National Electrical Code (NEC)] and, when applicable, are approved by a nationally recognized testing laboratory.

B. Provide new, currently-in-production products.

C. Do not use products that have been removed from existing premises, except as specifically and expressly permitted by contract documents or the SDR.

D. Use the products specified by standard industry names in Standard Drawing Equipment Schedule T-6001STD, unless specifically noted otherwise.

E. **Use products submitted for approval for the purpose intended.** No deviation from products listed in Standard Drawing Equipment Schedule is permitted without prior written permission from SNL/NM TIEG.

2.02 Delivery, Storage, and Handling

A. Provide the equipment necessary to handle, transport, and deliver products, including SFM, from storage site to work area.

B. Store products in original wrappings, and protect from dirt, weather, and construction work traffic.

C. Coordinate with the SDR at least three days in advance to pick up SFM.

D. All controlled information will be provided as prescribed by agreements with the SNL/NM contracting office.

E. Inspect products thoroughly for damage before taking custody, including SFM.

1. Inform the SDR within one work day if SFMs are found to be damaged, and provide documentation with sufficient engineering data to confirm the defect. If OF is obtained from SNL/NM, it is the contractor's responsibility to perform testing to ensure all fiber is undamaged before the fiber is removed from the SNL/NM storage facility. It is the responsibility of the Contractor to replace any untested fiber found to be damaged and to remove it from the SNL/NM storage facility at their expense.
2. Supply replacement SFM materials only after defective materials have been returned to the SDR and the defect confirmed.
3. If SFMs are rendered unusable and the Telecommunication SDR determines it was because of contractor error or improper installation, the materials must be replaced at contractor expense. Return unused SFM with an inventory to the Telecommunication SDR immediately after product use is complete.

2.03 Telecommunication Cabling and Termination Components

A. General

1. Refer to the Telecommunications Equipment Schedule standard drawing T-6001STD for approved equipment information including manufacturer and model numbers.
2. The drawings contain an equipment list of certain items to be provided by the contractor. For those items, no substitutions are permitted.
3. Follow the manufacturer's instructions for storage and installation for interbuilding and intrabuilding cabling.
4. Termination components for CommScope-specific and ADC-specific items are specified in the Telecommunications Equipment Schedule Standard Drawing T-6001STD; substitutes are not accepted.

B. Interbuilding

1. RED and BLACK Data Systems Optical Fiber Cable (CommScope-specific):

   a. For single-mode, follow the manufacturer's type, fiber counts, part numbers, and material identification on the drawings; substitutions will not be accepted.

   b. Supply cable on reels of continuous lengths without splices.

2. Voice Copper Cable (Superior Essex-specific):

   a. Outside plant copper cable: Designed for duct applications where protection from moisture is required. Filled outside plant copper cable must meet the requirements of ANSI/ICEA S-84-608.

   b. 4200 pair cable – 26 American wire gauge (AWG)

   c. 2400 pair and smaller – 24 AWG

   d. Conductors – soft annealed copper

   e. Insulation: Dual insulated with an inner layer of foamed, natural polyolefin covered by an outer layer of solid colored polyolefin. The conductor insulation is color coded in accordance with industry standards.

   f. Twisted pairs: Individual conductors are twisted into pairs with varying lay lengths to minimize crosstalk, and specific color combinations to provide pair identification.

   g. Core Assembly: Cables of 25 pairs are assembled into units that are then used to assemble the core. Units are individually identifiable by color-coded unit binders.

   h. Filling Compound – The core assembly is filled with an 80°C extended thermoplastic rubber compound, completely filling the interstices between the pairs under the core wrap.

   i. Core Wrap – A non-hygroscopic, dielectric tape applied over the core assembly to provide protection for the core.

j. Shielding – Corrugated, copolymer coated 8-mil aluminum tape applied longitudinally with an overlap.

k. Jacket – Black low-density polyethylene.

l. Jacket Markings – Manufacturer’s identification, pair count, AWG, product identification, and a telephone handset printed at 2-foot intervals. Sequential footage markings printed at alternate 2-foot intervals.

m. Packaging – Shipped on reels per manufacturer's recommendations. Ship cables 900 pair and larger on steel reels.

3. Cable Closures

a. Pressure tight, re-enterable rated for the environment installed in outside plant -maintenance holes, pedestals, direct buried, or indoor at service entrance.

b. Complete with cover, endplates, and all required components for cables being spliced.

4. Protectors

a. Frame or cabinet-mounted with required protector unit plug-in modules. Protected terminals must meet the primary protection requirements of UL 4.9.7, the mechanical and reliability requirements of TIA/EIA 758, and ANSI/TIA/EIA-568-C, 568-A.

5. Splice Modules

a. 710 modules are manufactured by the 3M™ Company.

b. Bridge taps are not to be installed without approval of the SDR.

C. Intrabuilding:

1. BLACK GPON data components (TE Connectivity-specific)

a. For all GPON installations use materials listed in Telecommunications Equipment Schedule T-6001STD; substitutes are not accepted.

2. Voice Copper Cable (CommScope-specific)

a. Use the cable as specified by manufacturer, pair counts, part numbers, and material identifications in Telecommunications Equipment Schedule T-6001STD; substitutes are not accepted.

b. Supply cable of continuous lengths without splices on reels or in boxes.

c. Follow the color codes shown in Table 3.2 for termination of conductors in each twisted pair cable.

3. RED Data Optical Fiber Cable (CommScope-specific)

a. For both multi-mode and single mode, follow the manufacturer's type, fiber counts, part numbers, and material identification as specified in Telecommunication Equipment Schedule T-6001STD; substitutions are not accepted.

b. Supply cable on reels of continuous lengths without splices.

c. Follow the color codes shown in Table 3.3 for the termination of fiber optic cables.

2.04 Labels

A. Interbuilding Cables

1. RED and BLACK OF Cables: Use self-laminating yellow label tags with cable-tie-wraps. Text must be mechanically generated using a block 14-point font producing black characters on a yellow background. See standard drawing T-1001STD.
2. Voice copper cables: Use pressure-sensitive, self-adhesive block letters and numbers. Text must be mechanically generated 1-inch bold black block characters on an orange background.

B. Intrabuilding Cables

1. Use a portable labeling system printer, Brady® LS2000 or a system of equal capability approved by the SDR.
2. Refer to section 3.06 for details on labeling intrabuilding cables.

C. RDT Labels

1. All RDTs must be labeled with a Micarta™ nameplate (black background with 1-inch high white lettering). The nameplate must include the RDT number as defined on standard drawing T-6001STD.
2. Label lay-in ceiling tile grid below RDT with Brother P-Touch® label (Yellow background with ¾-inch-high black letters). Include RDT number as defined on drawings.

D. FDH, FSB Labels

1. All FDHs and FSBs must be labeled with a Micarta nameplate (black background with 1-inch high white lettering). Nameplate must include the MDR/IDR number as defined on standard drawing T-6001STD.

E. Voice Frame and RED and BLACK Equipment Cabinet Labels

1. All equipment cabinets and voice frames must be labeled with Micarta™ nameplates on the front and back of cabinet. BLACK equipment cabinet labels are black in color with white engraved lettering as defined on standard drawing T-5004STD. RED equipment cabinet labels are red in color with black lettering as defined on standard drawing T-5002STD.

F. RED and BLACK pull boxes

1. All pull boxes must be labeled with Micarta nameplate on the front of the hinged cover. The label for the BLACK pull box is black with white engraved lettering as defined on standard drawing T-9001STD. The RED pull box label is red in color with black lettering as defined on standard drawing T-9002STD.

Part 3 - Execution

3.01 General

A. Site Inspection Reports

1. Do not begin work until a detailed inspection of the existing site has been performed and a Site Investigation Report has been submitted to the TIEG. Verify the following items:
   a. The information presented in the contract documents is correct or take the following action:
      i. Show proposed modifications and reasons for change, including specification sheets and written functional requirements to support findings.
      ii. Include drawings and other data required to show variations and corrections. Drawings and this specification must be available on site for reference during construction.
      iii. Indicate the associated costs to accommodate existing site conditions.
   b. Install equipment and accomplish the work as shown in the contract documents.
   c. Installation equipment and methods must be compatible with existing conditions.
   d. Include field measurements and other data obtained during the site inspection.
   e. If the SDR determines the work schedule might be affected by information presented in the Site Investigation Report, the SDR notifies the contractor. Revise the initial progress schedule, and resubmit it to the SDR for review and approval.
   f. When all conflicts between contract documents and site investigation information are resolved, certify in writing that the site investigation has been completed and includes the following items:
      i. Except for items noted, the conditions shown and described in the contract documents are correct.
      ii. Equipment can be installed, and work can be performed as specified without conflicts with existing site conditions.

B. Install products in accordance with NFPA 70 (NEC) except where industry standards like EIA/TIA provides more stringent requirements.

C. **Variations:** Drawings and other contract documents indicate the basic location, arrangement, and routing of equipment and components. If there are any variations from these specifications, based on the site investigation outlined in section 3.01A or for other reasons, do the following:

1. Submit a detailed description of proposed improvements and modifications to the SDR for review. Include drawings, manufacturer's literature, and a detailed description of functional improvements.
2. Do not incorporate modifications and associated work until receiving written approval from the SDR.

D. BLACK GPON Data

1. **Warning:** GPON operates using Class 1 laser product. Use the appropriate precautions and proper personal protective equipment when working with fiber. **Never** view the fiber with a naked eye.
2. In new buildings the following general method must be used:
   a. A fiber distribution hub (FDH) must be installed in the intermediate distribution room (IDR).
   b. Rapid fiber distribution terminals (RDTs) must be installed throughout the building.
   c. GPON user outlets must be installed adjacent to voice outlet locations and within 5 feet of a 120V receptacle. The power cable is to be installed neatly and at 90 degree when transitioning to receptacle.
   d. Plenum-rated multiple termination push-pull latch fiber optic (MTP) cabling must be installed from the RDTs to the FDH using plenum rated adjustable cable support systems.
   e. Drop cables must be installed from RDTs to user outlets using plenum rated adjustable cable support systems, and conduit concealed in walls.

E. Voice

1. In new buildings, the following general method must be used:
   a. Each outlet must include one plenum-rated CAT-5e 4-pair copper cable terminated in a User Outlet with an 8-pin modular jack.
   b. Cables are routed in plenum-rated adjustable cable-support system and terminated on 110 hardware.
   c. Drop cables must be installed from IDR to user outlets using plenum rated adjustable cable support systems, and conduit concealed in walls.

F. RED Data

1. Warning. FO operates using laser products. Use the appropriate precautions and proper personal protective equipment when working with fiber. Never view any fiber with a naked eye.
2. In new buildings the following general method must be used:
   a. Each RED telecommunications outlet must include two 4-strand 50-micron OM-34 multimode cables terminated with SC connectors. Install OM-4 multimode cables if the fiber length exceeds 984 feet and is less than 1804 feet.
   b. Cables are routed in a continuous conduit system from user outlet to IDR.
   c. For general RED IDR layout and conduit pathway, see standard drawings T-1001STD and T-9002STD.

3.02 Typical Outlet Configuration for Each User Location

A. General

If drawings or other contract documents indicate installation of less than the minimum capability described, notify the SDR and the TIEG immediately. Deviations from the minimum standard must be authorized in writing from the TIEG before installation. Each User Outlet described below is independent of the others.

B. BLACK GPON Data (TE Connectivity-specific)

1. Install an ONT at each GPON user outlet location. Reference standard drawingsT-5001STD.
2. An ONT back plate is required for each ONT. Mount back plate to vertical wall or furniture surface using two mounting screws sized to fit into mounting holes in ONT back plate. Use approved anchoring methods to attach to the vertical surface.
3. Mount the ONT level.
4. The ONT must be mounted within 5 feet of a 120 volt receptacle to ensure the power cable is installed in a neat and workmanlike manner and at 90 degree angles for transitions. Coil any excess power cabling in the ONT back plate. See standard drawing T-5001STD.
5. Install the ONT power supply, plug into a 120 volt receptacle, and plug into the ONT.
6. Attach power supply cord suppressor to bottom of ONT with an industrial strength self-adhesive cable tie mount and zip tie. See standard drawing T-5001STD.
7. Install the SM optical fiber from the RDT or FSB to the ONT. Secure the ONT Laser Lock. Place 8 inches to12 inches of SM cable slack in the ONT back plate to ensure that the cable label is visible.
8. Do not install any cabling directly below ONT ports. Allow space for future port connection cables.
9. When RED and GPON are installed, maintain proper separation per the Sandia New Mexico Transmission Security Checklist (see Section 1.03.D).

C. Voice (CommScope-specific)

1. Each outlet must include one 4-pair copper cable terminated in a User Outlet with an 8-pin modular jack. See Standard DrawingT-5001STD and Equipment Schedule T-6001STD for product specifications.
2. Install faceplates for voice.

D. RED data (CommScope-specific)

1. Each outlet must include two 4-strand 50-micron OM-4 multimode cables. See standard drawing T-5002STD and Equipment Schedule T-6001STD for product specifications.
2. Install plastic user outlet box, front covers, back panels, and associated user outlet parts.

3.03 Pathways

A. BLACK GPON Data

1. Install a plenum-rated adjustable cable support system approved for such use by a nationally recognized testing laboratory such as Underwriters Laboratories (UL). This must support exposed cabling above the ceiling space at intervals of no greater than five feet on-center.
2. Horizontal cabling bridging any inaccessible area must be installed in conduit.

3. The installed adjustable cable support system must be sized for no more than 50 cables with runs parallel or perpendicular to walls and structural members. It must also be parallel to intersection of vertical planes and ceilings and must remain accessible after all building utilities have been installed

B. Voice

1. Install a plenum rated adjustable cable support system approved for such use by a nationally recognized testing laboratory such as UL. This must support exposed cabling above the ceiling space at intervals of no greater than five feet on-center.
2. Horizontal cabling bridging any inaccessible area must be installed in conduit.
3. The installed adjustable cable support system must be sized for no more than 50 cables with runs parallel or perpendicular to walls and structural members. It must also be parallel to intersections of vertical planes and ceilings and must remain accessible after all building utilities have been installed.

C. RED Data Conduit

1. Personnel performing installation, maintenance, or modification of a CDIN must be Q-cleared. Technically qualified L-cleared or uncleared persons may perform such work provided they remain under constant visual observation and supervision of a technically qualified Q-cleared person.
2. Install conduit so that it first enters the termination equipment cabinet in an IDR or MDR/MDC to avoid the use of a cable tray. It must be perpendicular to the cable tray or equipment cabinet (or ceiling).
3. Do not use horizontal conduit entrances, unless preapproved in writing by the TIEG.
4. Intrabuilding communications conduit must not exceed 180° of bend between pull boxes.
5. Conduit runs must not exceed 100 feet without a pull box. Special measures to protect cabling must be undertaken, in this case at the direction of the Telecommunication SDR. Conduits smaller than 2-inch must not be stubbed directly into the IDR. Instead, they must be routed into a backbone pull box that connects with larger conduits to the IDR.
6. Conduit must not exceed 30% fill for new construction. If additional cabling is installed in existing conduits, do not exceed 40% fill. A new conduit backbone must be installed once the existing backbone is at 40% fill.
7. Ensure that conduits are clean and free of obstructions before pulling cable.
8. Install grounding bushings and or protective bushing on all conduits before pulling cable.
9. Secure conduit in place with positive anchorage devices designed and sized to withstand stresses, vibration, and distortion.

10. Conduit condulets are not to be used for telecommunication cabling. The only exception will be the use of condulets designed especially for use with communication cabling and authorized by the SDR in writing prior to installation.
11. Surface-mounted EMT conduit from the user outlet to above the lay-in ceiling is highly preferred. Facilities SDR must provide an additional set of RED drawings for inspection by CDIN team and permanent storage.Conduits must be continuous intermediate metal conduit (IMC) that is terminated with locknut and bushing inside the junction box to which the data user outlet is mounted. Ensure that inaccessible (uninspectable) conduit pathways for RED data, from the ceiling space to a flush-mounted junction box behind a data user outlet are continuous conduit from inside the junction box within a wall to an accessible location such as above a lay-in ceiling. A TIEG PTS Inspector, designated by the SNL/NM PTS Coordinator, must inspect IMC before the conduit is covered (for example, by drywall).
12. IMC conduit can transition to electrical metallic (EMT) conduit in accessible areas.
13. Modular walls are treated the same as walls covered in drywall and must be inspected by the TIEG. If a continuous stick of IMC cannot be used, all conduit connectors and couplings rendered inaccessible require epoxy (JB Weld®). Consult with TIEG for installation methods. A TIEG PTS Inspector, designated by the SNL/NM PTS Coordinator, must inspect IMC before the conduit is covered.
14. Before opening or removing any wall that has telecommunications conduit, the contractor must check both sides of the wall for a warning sticker. The warning sticker reads, “Warning: This outlet and/or wall contains a communications Classified Distributive Information Network (CDIN) and/or is protected by tamper-indicating material. No construction is to take place without prior notice to the PTS Site Manager. Report construction or suspected tampering to the PTS Site Manager, 844-2316”. If a warning sticker is found, follow the instructions on the sticker to arrange for a TIEG PTS Inspector to be present when the telecommunications conduit is exposed. If TIPS is present on the conduit, dispose of it according to TIEG procedures.

D. Raceway and cable routing shown on drawings are not intended to show all support or mounting hardware, or raceway bends, kicks, offsets, and couplings.

3.04 Cable Installation

A. General

1. All BLACK GPON fiber must be pulled by a SNL/NM approved by a TE Connectivity Partner.
2. All interbuilding OSP fiber, intrabuilding Voice copper cabling and intrabuilding RED optical fiber cables must be pulled by a SNL/NM approved CommScope/Systimax Certified Business Partner.
3. The cable system must be installed following manufacturer's instructions and following the design in its entirety as described in SNL/NM's Statement of Work, on drawings, and in this construction standard specification.
4. If indirect attachments are used, match the grip diameter and length to the cable diameter and characteristics. Reduce pulling forces to ensure optical fibers or twisted pair copper conductors are not damaged from forces being transmitted to strength member.
5. Do not exceed maximum pulling tension specified by the cable manufacturer.

6. Inspect the cable jacket carefully for defects as the cable is pulled off the reel.
7. Take precautions during installation to prevent the cable from being kinked, crushed, or mishandled.
8. Do not exceed the minimum bend radius of the optical fiber cable as recommended by the manufacturer. The following minimum bend radius information is provided only as general guidance:
    a. Short-term no-load: 10 times outer diameter
    b. During installation: 20 times outer diameter
    c. At rest after installation: 10 times outer diameter
    d. Individual buffered fibers: 19 mm (0.75 inch)
9. For Interbuilding cable only, use pulling lubricant compatible with cable as recommended by cable manufacturer. Use lubricant that does not leave a residue that hardens, such as Polywater® or approved equivalent.
10. Do not use cable lubricant for intrabuilding cables.
11. If deviations from drawings are required, the SDR must approve them before the affected cables are placed.
12. Install as directed by manufacturer's recommendations and in accordance with manufacturer's training program.

B. Interbuilding Cable

1. Service loops for outside plant optical fiber cable terminated within the building must be a minimum of 12 feet in termination cabinet, or as shown on drawings.
2. Provide a 25 foot service loop stored on a Sno Shoe in the maintenance hole nearest the building being served when an outside plant optical fiber cable is installed.
3. Provide minimum 25 feet of service loops for OSP copper cable within the building or maintenance hole or as shown on drawings. Termination will be done by SNL/NM personnel.
4. Maintenance Holes
    a. When installing fiber optic and copper cables, place cable on support arms at each wall insert. Secure OSP copper cable to support arms with nylon cable ties and Velcro® brand hook and loop fasteners for OSP fiber.
    b. Dress cables; maintain cables parallel to floor of maintenance hole as much as possible.
    c. When installing copper cables, populate lowest ducts first, working upward.
    d. Do not block ducts with cables.
    e. Interbuilding cable slack must be in maintenance holes and not under raised floors.
    f. Clean and remove all debris from maintenance affected by the installation of interbuilding OSP cable.
5. Splices and Enclosures
    a. Splices are only permitted as shown on drawings with written approval by SDR.

b. Bond to manhole ground ring with a #6 AWG bare copper conductor.

c. Splicing RED fiber optic cable is not permitted.

d. The extension of CDIN (RED) to a building requires that the final termination in the RED equipment cabinet in the MDR is completed only when the building is fully within the limited area.

C. Intrabuilding Cabling

1. Horizontally Installed Cable (BLACK GPON data and voice cabling)

   a. Black GPON data OF and Voice copper cable is plenum-rated and routed in ceiling space as shown on the drawings.

   b. Horizontal cabling bridging any inaccessible area must be installed in conduit.

   c. Install cable according to manufacturer's recommendations.

   d. Clean optical fiber connectors before connection according to manufacturer's recommendations.

   e. Install cabling in a plenum-rated adjustable cable support system as defined in section 3.03, *Pathways.* Do not use ceiling grid or a ceiling grid support system for cable support. Maintain a minimum six inches of clearance above lay-in ceiling to avoid damage during routine maintenance.

   f. Install bundles of no more than 50 cables with runs parallel or perpendicular to walls and structural members. Cable must also be parallel to intersections of vertical planes and ceilings and must remain accessible after all building utilities have been installed.

   g. All copper cable must be routed to avoid possible transmission interference or degradation from all electrical magnetic interference (EMI) sources present within the ceiling spaces, plenums, floors, and walls where such cabling is installed. (For example, electrical ballast in light fixtures causes EMI, which can interfere with how the cable performs.)

   h. Individual voice copper cable lengths must not exceed 300 meters (984 feet) from an IDR termination frame to a voice outlet. If a cable length exceeds this distance, notify the SDR. Do not place any cable at longer distances until so directed by the SDR.

   i. Install RED optical fiber cables through conduit and pull boxes as shown on the drawings.

2. Vertically Installed Cable

   a. Start installation at the top of the run and work toward the bottom of the run using gravity to assist.

   b. Monitor the pulling tension and do not exceed the manufacturer's specified cable-tension limits if machine assistance is required.

3. Pull Boxes

   a. Install Velcro cable support to the top of pull boxes to support cable from dropping out of box when the cover is opened.

D. **Installation cable-slack requirements are intended to minimize wasting cable.** After the cable has been installed, the slack must be as shown on the drawings. If it is not shown or noted, provide pre-termination cable slack as indicated below:

1. BLACK GPON (pre-terminated cables)
   a. At ONT location, provide an 18-inch slack loop or coil. Coil slack in box or on ONT bracket. The remaining slack is to be neatly coiled above ceiling at drop location.
2. Voice cabling, four-pair (before termination)
   a. Telephone Outlet: Not less than 1.5 meters (5 feet) or more than 2 meters (6.5 feet)
   b. IDR Termination Frame: All cables must be able to reach furthest frame location plus 1 meter (3.2 feet).
3. Copper Cables greater than four-pair (before termination)
   a. Not less than 5 meters (16.4 feet) beyond designated termination point or more that 10 meters (32.8 feet).
4. RED Optical Fiber Cables (before termination)
   a. User Outlet: Not less than 1.5 meters (5 feet), nor more than 2 meters (6.5 feet)
   b. Fiber shelf: Not less than 2 meters (6.5 feet) or more than 2.5 meters (8.2 feet).
   c. Lightguide Interconnection Unit (LIU): Not less than 2 meters (6.5 feet) or more than 2.5 meters (8.2 feet).

E. **Cable Placement within MDR or IDR:** Route cables to termination points in the most direct possible path.

1. Install voice copper cabling so that it enters the IDR or MDR on the BLACK side of room and drops in above the termination frame to avoid the use of cable tray. Copper cabling in not allowed in fiber cabinets.
2. Ensure that cable bundles are combed and that each cable runs parallel to other cables.
3. Separate cables into bundles according to routing requirements and termination points after combing and straightening cables.
4. Secure cable bundles with the Velcro strap material listed in standard drawing T-6001STD Equipment Schedule. Do not use cable ties manufactured from hard polymer material, such as plastic or nylon.
5. Begin to comb, bundle and strap cables within 2 inches (51 mm) of exit from conduit. Apply cable straps to bundles at intervals no greater than 12 inches (305 mm) for the entire length of the vertical and horizontal run.

F. Splices

1. Interbuilding Voice Copper and Optical Fiber Cable
   a. All splicing for the OSP voice cable in the maintenance hole must be done by the SNL/NM Telecommunication group unless specifically directed by the Telecommunication SDR.
   b. The BLACK optical fiber between the building IDR and the MDR serving the building is not to be spliced unless directed by the Telecommunication SDR.
   c. RED optical fiber between the building IDR and the MDR serving the building is to be continuous and without splices. Splicing RED optical fiber is not permitted.

2. Intrabuilding Voice Copper- and Optical Fiber-Cable
   a. Splices are not allowed in user drop voice cable or user drop fiber data cable excepted as listed in items b and c.
   b. Fusion-splices are to be installed in splice panels, connecting FDH cables to existing BLACK single mode cables to user outlets in IDRs.
   c. In buildings 810, 821, 823, 836, 870, 890, 891, 897, 905 and 962, where the existing BLACK user outlet contains CommScope single mode fiber, the fiber is fusion spliced in the IDR and terminated with STII+ single-mode connector at the BLACK user outlet.
   d. Splicing RED optical fiber is not permitted.

G. Rack-mounted OF Termination Panels

1. Install rack-mounted shelves with termination panels as described in contract documents. Fiber must be terminated and placed in termination panels. Termination panels will be installed in equipment cabinets. Install termination panels so that the front face of the panel is mounted eight inches back from the front door of the equipment cabinet.
2. Install couplers and their support panels for optical connections at both ends of optical cables.
3. Cover optical connectors, couplers with clean optical dust caps of the appropriate type.

H. Telephone Frames

1. Install as described in contract documents.
2. Frames must be secured to the floor.
3. The top of the frame must be secured to the back wall with a minimum of six inches from back of frame to wall.

I. Install FDH/FSB in IDR or other location as indicated on the drawings.

1. IDR Location
   a. Mount FDH/FSB to plywood backboard using manufacturer-recommended methods and SNL/NM fire protection specifications.
   b. Use "D" rings for cable management within IDR from cable entrance to FDH/FSB.
   c. Provide listed firestop assemblies when penetrating fire rated walls to match rating of wall.
2. FDH/FSB mounted in other than IDR.
   a. Mount FDH/FSB as detailed on drawings using manufacturer-recommended methods.
   b. Provide listed firestop assemblies when penetrating fire-rated walls to match rating of wall.

J. FDH/FSB Chart

1. Complete FDH/FSB chart. Templates for charts must be provided by TIEG.

K. Install RDT in an accessible location as indicated on drawings.

1. Above lay-in ceiling locations

a. Provide support from structural member with threaded rod and channel support system per detail on drawings.

b. Hallways are preferred. Avoid installing above office areas.

3.05 Grounding

A. General

1. Install telecommunication grounding per standard drawing T-1001STD and NEC.

3.06 Labeling

A. General

1. All cables, ONT, and outlet back plates must be labeled using a portable labeling system printer. SNL/NM preferred labeler for intrabuilding labels is a Brady® LS2000 or a system of equal capability approved by the SDR.

B. Interbuilding Cables: For OSP copper and OF cable.

1. Label each cable end with a unique identifier in the MDR/MDC and IDR. Identify entire exposed cable path with the minimum classification level of processing, i.e., unclassified processing (white tape) and classified processing (red and white candy-striped tape). For raised floors, cable must be taped and labeled every ten feet.
2. For the entire pathway, label each cable as it enters and exits each maintenance hole.
3. For OSP copper cables and OF cable, label each cable end with a unique identifier. The interbuilding cable names must include the building numbers from point of origin to destination. See standard drawing T-1001STD.

C. Intrabuilding Cables: For copper and OF cable, label each cable end with a unique identifier. See standard drawings for label specification and sequence of information.

1. BLACK GPON Cabling
   a. The cables serving an ONT from an RDT or FSB are pre-labeled by the manufacturer with a factory-unique identifier.
   b. Label 12-fiber MTP/multi-fiber push on (MPO) cable(s) in FDH with the associated RDT number.
   c. The OLT fiber jumper is labeled with OLT number, port, and fiber name. See standard drawing T-5001STD.
2. Voice and RED Data Cabling
   a. The floor designation for horizontal cables and cables to desktop must be the same as the desktop outlet location.
   b. The floor designation for backbone cables, cables from MDR/MDC to IDR, and IDR to IDR must be the floor where the cable originates, with the origin point being the MDR/MDC.

c. SNL/NM TIEG must provide guidance on the numbering sequence information for cabling projects. If any of the characters change, with the exception of last four, then the numeric sequence must start at 0001. See standard drawing T-5003STD.

D. **Copper Cable 110 Wiring Blocks:** Floor-standing frames with 110-type wiring blocks must be used; refer to Standard Drawing Equipment Schedule for the product part numbers.

1. Wire punched down on 110 wiring block must be labeled on 110 wiring blocks as individual pairs.
2. Label 110 wiring block pair count using a Microsoft® Office Excel spreadsheet template, together with a color transparent plastic strip for color-coding. Voice 110 wiring block labels must be distinguished by the following abbreviations:

Voice Frame Example: 836FAVC
VT = Voice Campus Cable
VM = Voice Backbone Cable
VP = Voice ISDN Power Cable
VU = Voice Horizontal Cable

3. Provide floor-standing frames as indicated in standard drawing Equipment Schedule. Designate groups of blocks as campus cables, ISDN power cables, and horizontal voice cables. See Standard Drawing T-5004STD for layout.
4. Install label on each floor-standing frame. See Standard Drawing T-5004STD, and Figure 3.1, *SNL/NM Copper Label and Wiring Detail* for label specification and sequence of information.

E. **Lightguide Interconnection Unit (used in IDRs with existing LIUs or small FSB installation)**

1. Attach the label to the door of an LIU. The LIU label must have a building number, IDR number, and numeric sequence.
2. List cable(s) and room number on the LIU with the LIU name. Provide a continuous numbering sequence for individual fibers. Number individual fiber strands in the LIU from 1 through 24 for cables with 24 fiber strands or fewer.
3. Use multiple LIUs for cables with more than 24 fiber strands, and label sequentially according to the number of fiber strands.
4. See standard drawing T-5003STD for LIU labeling.

F. **Telecommunication Cabinet: Includes Floor-Standing and Wall-Mounted Cabinets**

1. Cabinet labels must have the building number, color designation for classification of network, IDR number, and sequential character. See standard drawings T-5002STD.
2. Label RED (SCN) and BLACK (SRN/SON) cabinets as two separate systems.
3. Center the label at the top of the front and back doors of the cabinet.
4. Sequential characters must start over when any of the other characters change.

G. Fiber Termination Shelf

1. A single shelf can hold more than one campus, backbone, or horizontal cable. Do not split a single cable between shelves without SDR approval. Start the numbering sequence from 1 within the shelf, and continue to the last fiber strand within that cable for cable larger than 4 fibers. See standard drawing T-5004STD for layout.
2. Each shelf must contain either single-mode or multi-mode fiber; not both.
3. Label shelves of four-fiber user cables according to the outlet and room numbers.
4. All fiber terminated in an IDR/MDR/MDC without existing LIUs must terminate in a fiber shelf installed in a telecommunications cabinet. BLACK fibers must terminate in a BLACK cabinet and RED fibers must terminate in a RED cabinet.

H. BLACK GPON ONT

1. SNL/NM TIEG provides the three label stickers for BLACK GPON outlets: the black computer data sticker, the white GPON sticker, and the yellow laser sticker.
2. Attach the black computer data sticker with the pre-assigned numeric value to the ONT mounting bracket. See standard drawing T-5001STD for examples of sticker placement.
3. Install white label sticker to the ONT and complete the serial and box number using a portable labeling system printer.
4. Install the yellow "Laser Caution" sticker to the ONT.

I. Voice Copper Outlet

1. SNL/NM TIEG provides label stickers for voice outlets.
2. Attach the sticker with the pre-assigned numeric value to the faceplate for the appropriate outlet. See standard drawing T-5001STD for examples of sticker placement.

J. RED Data Outlet

1. SNL/NM TIEG will provide the two label stickers for each RED data outlets. The red computer data sticker and the warning sticker.
2. Attach the RED warning sticker with the preassigned numeric value to the outlet cover for the appropriate outlet. This sticker is SFM. All RED outlets must have a warning sticker that reads, "**Warning**: This outlet and/or wall contains a communications Classified Distributive Information Network (CDIN) and/or is protected by tamper-indicating material. No construction is to take place without prior notice to the PTS Site Manager. Report construction or suspected tampering to the PTS Site Manager, 844-2316." See standard drawing T-5002STD for examples of sticker placement. Do not reuse existing box numbers when outlets are moved or reterminated.
3. Attach a Brady label to the back of the outlet plates with the same number as used in performing item J1, above.
4. Attach a label on the inside cover of the fiber outlet indicating the company name, date tested, and technician doing testing and termination.

5. Attach the red computer data sticker with the pre-assigned numeric value to the faceplate for the appropriate outlet. See standard drawing T-5001STD for examples of sticker placement.

K. **Backbone conduit pull box:** Install the engraved plastic label on the outside cover of the pull box. See SNL/NM standard drawing T-9001.STD.

L. **Conduits and raceways must be color coded by means of ¾-inch Scotch #35 or equivalent tape applied at each joint and termination point.** Refer to Standard Drawing T-6001STD.

1. Use white tape for BLACK SRN and SON data networks and telephone conduits.
2. Use white/red striped tape for RED SCN network conduits.
3. Install a tie-wrap label tag on each conduit end point that terminates in an IDR, MDR or is stubbed through the floor, ceiling or wall without a pull box.
4. Use block lettering from a portable labeling system printer for tags in item #3. Lettering must be black in coloring on a clear background.
5. Match the label information to the information in the nearest junction box label to which the conduit leads.

M. RDT

1. Label RDT with number as shown on drawings.
2. Provide permanent RDT labeling on the outside of the door with Micarta® labels.
3. Label lay-in ceiling grid below RDT with RDT number with mechanical generated Brother™ P-6 Touch label.
4. Complete all fields for each RDT. Cable charts must be completed in electronic format.

3.07 Termination of Telecommunication Cable

A. Interbuilding Cables

1. BLACK and RED Optical Fiber Cables
   a. Terminate both ends of the cables with single mode LC type connectors.
   b. Cable slack must be in maintenance hole or as shown on drawings, not in MDR raised floors or IDR.
   c. Terminate in accordance with cable and connector manufacturer's specifications.
   d. Insure Intrabuilding cabling is secured to avoid pull-back using cable clamp.
   e. Install break-out kit(s) for transition to termination enclosure.
   f. See standard drawing T-6001STD for Equipment Schedule parts list.
2. Voice Copper Cables
   a. At maintenance hole, provide fifteen feet of slack for terminations by SNL/NM personnel.
   b. In IDR, an indoor rated splice case must be properly bonded to ground bus per manufacturer's specifications.

c. Terminate all OSP copper on a UL-rated building entrance terminal for lightning protection.

B. Intrabuilding Cables

1. BLACK GPON cabling
   a. The horizontal cabling system serving GPON for FDHs, FSBs, RDTs, and ONTs are all pre-terminated by the manufacturer and have factory-unique identifiers.
   b. Buildings with legacy single-mode fiber are fusion spliced as defined in section 1.02 of this document.
2. Copper Cables
   a. For a clean dress at patch panel or frame, provide cables with enough cable slack to prevent stress and sharp bends on cables.
   b. Terminate in accordance with cable and connector manufacturer's specifications.
   c. At the user outlet, provide twelve inches of cable slack for four-pair cables to allow connector replacement.
   d. Install T568A eight-position, modular, four-pair copper connectors at user outlets and wall plates, as listed in Standard Drawing T-6001STD Equipment Schedule.
   e. Terminate four-pair cables in the IDR on 110 blocks as shown in Standard Drawing T-5004STD Equipment Schedule.
   f. Terminate copper cables maintaining wire pair twists as specified in EIA/TIA 568A.
3. RED Optical Fiber Cables
   a. Provide cable slack as shown on the drawings.
   b. Terminate in accordance with cable and connector manufacturer's specifications.
   c. After terminations, cables must have a minimum slack of one meter (three feet) at user outlet and 1½ meters (five feet) at LIU or fiber termination shelf.
   d. Braid aramid yarn strength member a minimum of 3 inches or long enough to secure to connection point.
   e. Firmly attach braided aramid yarn-strength members at both ends of the cable to prevent damage from fibers.

3.08 Testing Intrabuilding Cabling

A. General

1. All CommScope cables must be tested by a SNL/NM approved CommScope/Systimax Certified Business Partner.
2. If deviations from drawings are required, the SDR must approve them before the affected cables are tested.
3. The SDR or SNL/NM-Designated Alternate can witness field tests.

4. SNL/NM can perform independent testing at the discretion of the SDR.
5. The Contractor incurs all costs for retesting and consumables required by unacceptable test results.
6. Perform a Tier II (OTDR) and a link-loss (power meter) test on all RED fiber cables.

B. Test Equipment Preparation

1. Preparing Copper Cable Test equipment: properly configure equipment before testing, and include the following items:
   a. Verify the test equipment is within the manufacturer's calibration warranty period.
   b. Verify the test equipment is set to "auto test," and that proper cable type and associated parameters are selected. Ensure equipment's selected NVP matches the cable being tested.
2. Preparing Optical Fiber Test Equipment: Properly adjust OF test equipment before use.
   a. Follow the equipment manufacturer’s instruction manual.
   b. Calibrate variable unit adjustments on test equipment to match the cable manufacturer's cable transmission parameters.
   c. Ensure parameters meet Section 3.09-C.

C. Optical Fiber Cable and Component Test

1. BLACK GPON data
   a. Perform power meter test using a PON power meter. Test at ONT.
   b. Label each individual test result with the following: building number, room number, ONT number.
2. Use test equipment listed in Table 2 or SNL/NM-approved equivalent (only the TIEG can give such written approval) and perform the following inspection and tests for OF cable.
3. Properly clean the optical connector end faces before connector contact is made for testing or circuit connection.
4. Proof that all personnel testing RED optical fiber have Fluke Certified Cabling Test Technician certification.
5. Optical Fiber Connector Validation Test: Inspect each OF connector assembly with 200X filter only scope or greater visual inspection.
   a. Reject the connector assembly if visible imperfection penetrates the fiber core or if the imperfection risks future damage to the core or mating connector's surface.
   b. Reject the connector assembly if the connector loss displayed does not meet the manufacturer's specifications or exceeds the worst-case test values for the appropriate connector type according to section 3.10.
   c. Reject the connector assembly if the connector reflectance exceeds acceptable optical return loss (ORL) according to section 3.10.
   d. Replace rejected connector assemblies and retest until acceptable measurements are obtained according to section 3.10.

6. Optical Fiber Cable Length Measurement: Record cable length (in feet) from optical time-domain reflectometer (OTDR) measurements or Power Meter.
7. Ensure OTDR trace contains zero events and save to tester.
8. Optical Reference Level Measurements
   a. Connect the optical source to the power meter in accordance with manufacturer recommended jumper cables. Match jumper cable with cable being tested.
   b. Repeat this procedure during the measurement process to verify the integrity of optical fiber test jumpers and the optical source per manufacturer's recommendations.
   c. Label each individual test result with the following: building number, box number, cable name, fiber number (880 99999 FR1M0001 1).
9. Optical Link Attenuation Measurements: Measure optical link attenuation after both ends of the OF have been terminated and placed into coupling panels.
   a. Measure the link attenuation with an optical source and power meter and save to tester.
   b. Connect the source at one end of the optical link and connect the power meter to other end.
   c. Save the test results in dB for each wavelength to tester. Reverse the location of both source and power meter, and repeat the test.
   d. Save the average recorded power levels for each wavelength to tester.
   e. Label each individual test result with the following: building number, box number, cable name, fiber number (880 99999 FR1M0001 1).
10. Optical Link Return Loss Measurement: Measure and save to tester, the optical link return measurement for single-mode optical links.
    a. Submit final electronic test data using manufacturer's tester specific software (I.e. Link Ware).
    b. Label each individual test result with the following: building number, box number, cable name, fiber number (880 99999 FR1M0001 1).

D. Copper Cable Tests: Use the EIA/TIA-568-A-1 Use Minimum Level-3 tester to automatically perform the following tests:

1. Interbuilding Cabling
   a. Wire Map (End-to-End Connectivity)
   b. Length: Record cable length from test equipment. Ensure NVP values are set to manufacturer's specifications.
2. Intrabuilding Cabling
   a. Wire Map (End-to-End Connectivity)
   b. Length: Record cable length from test equipment. Ensure NVP values are set to manufacturer's specifications.
   c. Insertion loss Near End Cross Talk (NEXT) Loss
   d. Power Sum Near End Cross Talk (PSNEXT) Loss.

e. Equal Level Far End Cross Talk (ELFEXT)

f. Power Sum Equal Level Far End Cross Talk (PSELFEXT)

g. Return Loss

h. Propagation Delay

i. Delay Skew

j. The result of each test is either "pass" or "fail."

k. Repair or replace and retest failed cables until passing results are achieved.

l. Submit final electronic test data using manufacturer's tester specific software (I.e. Link Ware).

E. Test Reports and Cable Charts

1. File names must always start with RED OTDR, RED power meter for classified or BLACK GPON, and Voice for unclassified systems followed by the user outlet number.

3.09 Acceptance

A. Optical Network Terminal (ONT) Testing

1. The OLT power meter reading at user drop is to be between -8.0 dBm to -20.0 dBm at 1490 nm from OLT. Save the results and submit to TIEG.
2. The inline ONT power meter reading is to be between 0.5 dBm to 5.0 dBm at 1310 nm. Save the results and submit to TIEG.
3. Observe the ONT caution sticker when working with ONT. "CAUTION Invisible laser radiation when open. Do not remove cover. Do not disconnect cable. Class 1 laser product".
4. Upon final installation of the ONT, provide testing using the ONT indicator lights to assure the ONT is in a normal operating mode, bold text indicates normal operating conditions:

   a. Power

   - Green/Solid – operating from AC power.
   - Green/Flash – system booting.

   b. Optical

   - Green/Solid – ONT working normally.
   - Green/Flash – ONT is ranging and synchronization is in process.
   - Red/Solid – Optical interface abnormal (loss of signal).

   c. LAN

   - Green/Solid – at least one of the Ethernet links on the ONT is up.
   - Green/Flash – at least one of the Ethernet links on the ONT is up and there is activity of receiving and transmitting data.
   - OFF – no Ethernet link is up at the ONT or the ONT is not ready to run Ethernet service.

d. Update

- Green/Flash – ONT is being updated or upgraded.
- Red/Solid – There is a failure with the remote update process/upgrade failure.

e. Alarm

- Green/Solid – No alarm with local access enabled.
- Red/Flash – Software is out of order.
- Red/Solid – Hardware is out of order.
- OFF – No alarm.

5. Document and report any abnormal indications to the Telecommunication SDR.

B. **Optical fiber cable acceptance values are derived from approximately seventy percent (mean plus or minus one standard deviation) of component tolerances.** Values shown below represent the worst-case acceptability. Typical results should approach the manufacturer's published statistical averages.

C. **Worst-case test values, as shown in Table1, Optical Fiber Cable Test Forms, are derived from the following formula:**

1. Worst-case acceptable multi-mode optical link attenuations

a. 2 SC® connectors plus 300 ft. optical cable

= (2 x 0.55 dB) + (0.09 km x 3.4 dB/km)

= 1.1 dB + 0.31 dB

= 1.41 dB

1.4 dB for 850 nm

1.2 dB for 1300 nm

b. 2 LC® connectors plus 300 feet optical cable

= (2 x 0.2 dB) + (0.09 km x 3.4 dB/km)

= 0.4 dB + 0.31 dB

= 0.71 dB

0.7 dB for 850 nm

0.5 dB for 1300 nm

The above link attenuation formula is for multi-mode fiber cable lengths based on 300 foot 50-micron Systimax® LazrSPEED® 300 cable. If 550-OM-4 cable is installed for lengths between 984 feet and 1804 feet, use the appropriate dB/km loss per manufacturer's recommendation.

2. Worst-case acceptable single-mode optical link attenuations(OSP)
   a. 2 ST® II connectors plus 300 ft. optical cable

      = (2 x 0.55 dB) + (0.09 km x 0.4 dB/km)

      = 1.1 dB + 0.04 dB

      = 1.14 dB

      1.1 dB for both 1310 and 1550 nm

   b. 2 SC® connectors plus 300 ft. optical cable

      = (2 x 0.55 dB) + (0.09 km x 0.4 dB/km)

      = 1.1 dB + 0.04 dB

      = 1.14 dB for both 1310 and 1550 nm

   c. 2 LC® connectors plus 300 ft. optical cable

      = (2 x 0.2 dB) + (0.09 km x 0.4 dB/km)

      = 0.4 dB + 0.04 dB

      = 0.44 dB for both 1310 and 1550 nm

3. Worst-case acceptable optical link return loss:
   a. 2 ST® II connectors plus 300 ft. optical cable

      =35 dB for both 1310 and 1550 nm

   b. 2 SC® connectors plus 300 ft. optical cable

      =35 dB for both 1310 and 1550 nm

   c. 2 LC® connectors plus 300 ft. optical cable

      =35 dB for both 1310 and 1550 nm

4. Acceptance Data Required

Table 3.1 Acceptance Data Required

Cable Type	Wire Map Only	Cable Charts	Power meter	OTDR
OSP Copper (BLACK only)	X			
OSP Fiber (RED & BLACK)		X	X	X
GPON (BLACK only)		X	X	
VOICE (BLACK only)		X	X	
RED DATA (RED only)		X	X	X

Table 3.2 Copper Cable Termination Color Codes

4 Pair Cable	25 Pair Cable	100 Pair Cable			
		Binder			
		Blue	Orange	Green	Brown
1 WHITE/BLUE	1 WHITE/BLUE	1 WH/BL	26 WH/BL	51 WH/BL	76 WH/BL
2 WHITE/ORANGE	2 WHITE/ORANGE	2 WH/OR	27 WH/OR	52 WH/OR	77 WH/OR
3 WHITE/GREEN	3 WHITE/GREEN	3 WH/GN	28 WH/GN	53 WH/GN	78 WH/GN
4 WHITE/BROWN	4 WHITE/BROWN	4 WH/BN	29 WH/BN	54 WH/BN	79 WH/BN
	5 WHITE/SLATE	5 WH/SL	30 WH/SL	55 WH/SL	80 WH/SL
	6 RED/BLUE	6 R/BL	31 R/BL	56 R/BL	81 R/BL
	7 RED/ORANGE	7 R/OR	32 R/OR	57 R/OR	82 R/OR
	8 RED/GREEN	8 R/GN	33 R/GN	58 R/GN	83 R/GN
	9 RED/BROWN	9 R/BN	34 R/BN	59 R/BN	84 R/BN
	10 RED/SLATE	10 R/SL	35 R/SL	60 R/SL	85 R/SL
	11 BLACK/BLUE	11 BK/BL	36 BK/BL	61 BK/BL	86 BK/BL
	12 BLACK/ORANGE	12 BK/OR	37 BK/OR	62 BK/OR	87 BK/OR
	13 BLACK/GREEN	13 BK/GN	38 BK/GN	63 BK/GN	88 BK/GN
	14 BLACK/BROWN	14 BK/BN	39 BK/BN	64 BK/BN	89 BK/BN
	15 BLACK/SLATE	15 BK/SL	40 BK/SL	65 BK/SL	90 BK/SL
	16 YELLOW/BLUE	16 Y/BL	41 Y/BL	66 Y/BL	91 Y/BL
	17 YELLOW/ORANGE	17 Y/OR	42 Y/OR	67 Y/OR	92 Y/OR
	18 YELLOW/GREEN	18 Y/GN	43 Y/GN	68 Y/GN	93 Y/GN
	19 YELLOW/BROWN	19 Y/BN	44 Y/BN	69 Y/BN	94 Y/BN
	20 YELLOW/SLATE	20 Y/SL	45 Y/SL	70 Y/SL	95 Y/SL
	21 VIOLET/BLUE	21 V/BL	46 V/BL	71 V/BL	96 V/BL
	22 VIOLET/ORANGE	22 V/OR	47 V/OR	72 V/OR	97 V/OR
	23 VIOLET/GREEN	23 V/GN	48 V/GN	73 V/GN	98 V/GN
	24 VIOLET/BROWN	24 V/BN	49 V/BN	74 V/BN	99 V/BN
	25 VIOLET/SLATE	25 V/SL	50 V/SL	75 V/SL	100 V/SL

Table 3.3 Fiber Cable Termination Color Codes

4 Strand Cable	12 Strand Cable	48 Strand Cable			
		Binder			
		Blue	Orange	Green	Brown
1 BLUE	1 BLUE	1 BLUE	1 BLUE	1 BLUE	1 BLUE
2 ORANGE	2 ORANGE	2 ORANGE	2 ORANGE	2 ORANGE	2 ORANGE
3 GREEN	3 GREEN	3 GREEN	3 GREEN	3 GREEN	3 GREEN
4 BROWN	4 BROWN	4 BROWN	4 BROWN	4 BROWN	4 BROWN
	5 SLATE	5 SLATE	5 SLATE	5 SLATE	5 SLATE
	6 WHITE	6 WHITE	6 WHITE	6 WHITE	6 WHITE
	7 RED	7 RED	7 RED	7 RED	7 RED
	8 BLACK	8 BLACK	8 BLACK	8 BLACK	8 BLACK
	9 YELLOW	9 YELLOW	9 YELLOW	9 YELLOW	9 YELLOW
	10 VIOLET	10 VIOLET	10 VIOLET	10 VIOLET	10 VIOLET
	11 ROSE	11 ROSE	11 ROSE	11 ROSE	11 ROSE
	12 AQUA	12 AQUA	12 AQUA	12 AQUA	12 AQUA

Note: The above illustrates a 48 fiber cable, the binder color code follows industry standards for the number of binder groups in a optical fiber cable.

Table 3.4 SNL/NM-Preferred Test Equipment

Equipment	Manufacturer	Model
Optical Loss Return Loss		
Test Set	Fluke	DTX1800 or current model
	Noyes	Or current model
		Optifiber® or current model
OTDR	Fluke	
Optical Interferometer	Direct Optical Research Co.	Portable
	Norland Products Inc.	Portable
Copper CAT 6 Cable Tester	Fluke	DTX-1800

Note:

1. Copper cable testers must meet EIA/TIA current Level 3 requirements.
2. Attenuation must have accuracy within plus or minus 0.25 dB and reflectance within plus or minus 0.5 dB. Submit specifications on desired equivalents for review and approval before using them.

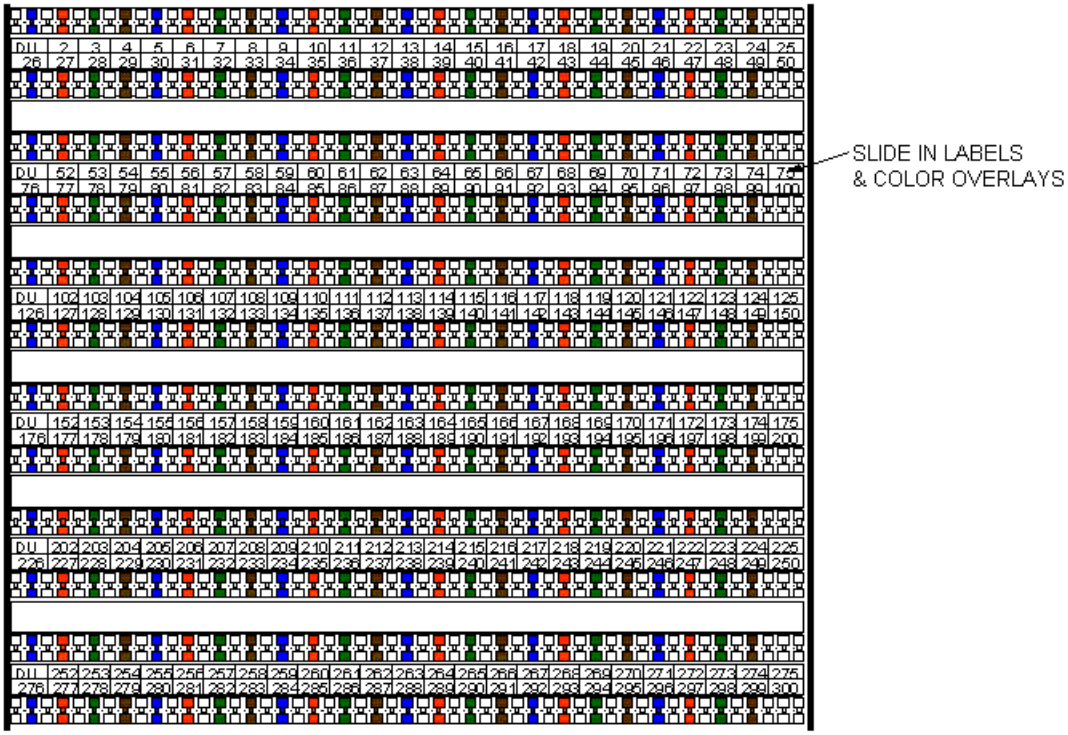

Figure 3.1 SNL/NM Copper Label and Wiring Detail

Table 3.5 illustrates the label color to be inserted above the numbers as indicated in Figure 3.1.

Table 3.5 110 Wiring Block with Labels and Color Code Overlays

Color	Termination Description
Orange	Interbuilding backbone termination (campus cable, outside plant cable)
White	Intrabuilding backbone termination, 1st level (i.e. MDR to IDR)
Gray	Intrabuilding backbone termination, 2nd level (i.e. IDR to IDR)
Blue	Horizontal voice termination (i.e. cable to outlet)
Yellow	Miscellaneous termination (i.e. auxiliary, security, alarms)