

CONSTRUCTION STANDARD SPECIFICATION

SECTION 16740

INTRA-BUILDING TELECOMMUNICATION OLD SYSTEM

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CONSTRUCTION STANDARD SPECIFICATION

SECTION 16740

INTRA-BUILDING TELECOMMUNICATION OLD SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Material and installation of cable, and termination and testing for intra-building telecommunication cabling for both new construction and remodeling projects at Sandia National Laboratories, New Mexico (SNL/NM).
 - 1. Install cable system design as described in Statement of Work in its entirety.
 - 2. Supply tools, consumables, and test equipment for Project.
 - 3. Cable termination and testing shall be performed only by Lucent-certified Value Added Reseller (VAR). Lucent sets the rules, performs the required training, and selects the companies who get VAR status. SNL/NM has absolutely no involvement in these activities or selections. It is SNL's intent to allow any Lucent-certified VAR company to perform this work in the pursuit of SNL/NM obtaining the required quality high speed communications cabling systems and their 20-year warranties.
- B. Drawings shall delineate intra-building cable system by locations of intermediate distribution room (IDR), user outlets, and rack frame and cabinet locations.

Raceways shown on Drawings are not intended to show all bends, kicks, offsets, and couplings.
- C. Project may contain both Red-Internal Secure Network (ISN), and Black-Internal Open/Restricted Access Network (IRN/EON) systems.

Red systems require special security procedures. Contact SNL/NM Protected Distribution System (PDS) Corporate Computing Help Desk (CCHD) site manager via 845-2243 for guidance.
- D. Project may have Contractor-furnished material and/or Sandia-furnished material (SFM) as detailed in Statement of Work.
- E. All or part of Work may be included in Project, as stated in Contract documents.

F. Related Sections: Refer to the following sections for related work.

1. Section 01330, "Submittal Procedures."
2. Section 16001, "Electrical Work."

1.02 REFERENCES

A. Electronics Industries Association/Telecommunications Industries Association (EIA/TIA)

568A Commercial Building Telecommunications Cabling Standard

TSB-67 Technical Service Bulletin (Cable Testing/Tester)

B. National Fire Protection Association (NFPA)

70 National Electrical Code (NEC)

C. Occupational Safety and Health Administration (OSHA)

29 CFR Part 1910 Permit-Required Confined Spaces for General Industry; Final Rule

D. Supplementary References: Publications listed below are not referenced in this Section. Publications are listed as they contain design and technical criteria that are pertinent to Project.

1. American National Standards Institute (ANSI)

Z136.1-1993 American National Standard for Safe Use of Lasers

TIA/EIA-4720000-A Generic Specification for Fiber Optic Cable

TIA/EIA-472C000-A Sectional Specification for Fiber Optic Communications Cable for Indoor Use

TIA/EIA-472CAAA Detail Specification for All-Dielectric (Construction 1) Fiber Optic Communications Cable for Indoor Plenum Use, Containing Class Ia, 62.5 Micron Core Diameter/125 Micron Cladding Diameter Optical Fiber(s)

2. Bell Communications Research, Inc. (Bellcore)

TA-NWT - 000198 Generic Requirements for Optical Loss Test Sets (OLTS)

TR-TSY - 000886 Generic Criteria for Optical Power Meters

TR-NWT - 001137 Generic Requirements for Hand-Held Optical Power Meters

- TR-NWT - 001138 Generic Requirements for Mini-OTDRs and Fiber Break Locators
3. Building Industry Consulting Service International (BICSI)
Telecommunications Distribution Methods Manual
LAN Design Manual
 4. Electronics Industries Association/Telecommunications Industries Association (EIA/TIA)
455 Series Fiber Optic Component Testing
526 Series System or Subsystem Test Procedures
569 Commercial Building Standard for Telecommunications Pathways and Spaces
570 Residential and Light Commercial Telecommunications Wiring Standards
606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
607 Commercial Building Grounding and Bonding Requirements for Telecommunications
 5. Federal Information Processing Standards (FIPS) Publication 94
Guideline on Electrical Power for ADP Installations
 6. Insulated Cable Engineers Association, Inc. (ICEA)
S-80-576 Standard for Telecommunications Wire & Cable for Wiring of Premises
 7. Underwriters Laboratories Inc. (UL)
94 Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
910 Test Method for Fire and Smoke Characteristics of Electrical and Optical - Fiber Cables Used in Air-Handling Spaces.
1449 UL TVSS 1449 Transient Voltage Surge Suppression
1666 Standard Test for Flame Propagation Height of Electrical and Optical - Fiber Cables Installed Vertically in Shafts.

1.03 DEFINITIONS

- A. Intra-Building Cable: Cable within building.
- B. Inter-Building Cable: Cable between buildings.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract documents and Section 01330, "Submittal Procedures."
- B. Site Investigation Report: Submit as required in Part 3 for remodel work.
- C. Manufacturer's Data: Provide manufacturer's data for specified materials and equipment that are not listed in Tables 1, 2, or 3.
- D. Test Equipment: Provide list of proposed test equipment to be used for Contractor-performed tests.
 - 1. Provide detailed, written description of test procedures and equipment usage specific to SNL optical fiber (OF) and unshielded twisted pair (UTP) testing activities.
 - 2. Provide complete technical specifications for OF and UTP test equipment, if Contractor uses equipment other than Sandia-preferred equipment.
 - 3. Provide software revision level number for test equipment that use software or firmware.
 - 4. Provide current copy of manufacturer's calibration certificate for each piece of test equipment, with traceability to National Institute of Standards and Testing (NIST) requirements.
- E. Quality Control
 - 1. Test Reports: Submit certified copies of test reports for Contractor-performed tests within one week after performance of test. Large scale tests require progressive submittals on weekly basis.
 - 2. Procedures: Provide the following, prior to beginning Work.
 - a. Written, detailed procedures including techniques for securing, protecting, and dressing transitions from OF and enhanced unshielded twisted pair (EUTP) cable to conductor to connector.
 - b. Written, detailed termination procedures for OF and EUTP conductors.
 - c. Written company quality policy including measures to be taken throughout Contract to ensure delivery of quality work to SNL.
 - 3. Contractor Qualifications: Provide certification that Contractor meets Quality Assurance requirements prior to beginning Work. Include the following:

- a. Project list with descriptions of past projects that are similar in size, scope, complexity, and use of hardware. Provide client name, project manager, address, and current telephone number for each project listed. Project list shall document at least five years of corporate experience in termination and testing OF and EUTP cable.
 - b. Qualifications and training certifications of proposed on-site personnel. Include documentation verifying at least five years of field experience in OF and EUTP termination and testing. Provide copies of pertinent training certificates.
- F. As-Built Drawings: Submit dated as-built drawings for review with Sandia Delegated Representative (SDR) at two-week intervals, beginning at Project start date, or as specified in Drawings.
1. Call attention to entry by circling affected area.
 2. If as-built work is not complete, Contractor will be so advised by SDR, and Contractor shall complete work as required.

1.05 QUALITY ASSURANCE

- A. Material and installation shall meet requirements of NFPA 70.
- B. Material, when applicable, shall be approved by Nationally Recognized Testing Laboratory (NRTL).
- C. Monitor and maintain quality control over manufacturers, suppliers, subcontractors, work force, site conditions, products, and services to ensure Work is of specified quality.
- D. Workmanship: Install material and equipment in neat and workmanlike manner, in accordance with NEC Article 800-6.

Specified requirements represent minimum acceptable quality for Work. Comply with industry standards except when more stringent requirements are specified, and tolerances indicate higher standards or more precise workmanship.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide equipment necessary to handle, transport, and deliver materials, including SFM, from storage site to work area.
- B. Store components in original wrappings, and protect from dirt, weather and construction work traffic.
- C. Coordinate with SDR at least three days in advance for pick up of SFM.
- D. Thoroughly inspect materials for damage before taking custody, including SFM. Inform SDR within one workday if SFM are found to be damaged. Failure to do so may result in material replacement at Contractor's expense as determined by SDR.

- E. Return unused SFM with an inventory to SDR immediately after product usage is complete.

1.07 WARRANTY

- A. If items supplied as part of Project have warranties longer than one year from date of final acceptance, Contractor shall supply longer warranty.
- B. Written statement ensuring performance of entire installation of twisted pair cable and optical fiber cable for minimum period of 15 years, starting from day of acceptance, shall be submitted by SNL-approved Cable Termination and Testing Contractor.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide products that are new and currently in production.
- B. Do not use materials and equipment that have been removed from existing premises, except as specifically permitted by Contract documents or SDR.
- C. Products will be specified by industry standard names, unless specifically noted otherwise.
- D. Devices submitted on shall be for the purpose it was intended. No deviation from SNL requirements and standards shall be permitted.

2.02 INTRA-BUILDING TELECOMMUNICATION CABLING AND TERMINATION COMPONENTS

- A. Twisted Pair Copper Cable: Provide manufacturer type, pair counts, part numbers, and comcodes as found in Table 2.
 - 1. Substitutes shall not be accepted.
 - 2. Supply cable on reels of continuous lengths without splices.
 - 3. Follow color codes shown in Table 1 for termination of conductors in each twisted pair cable.
- B. Optical Fiber Cable: Substitutes shall not be accepted.
 - 1. Multi-Mode: Manufacturer type, fiber counts, part numbers, and comcodes specified in Table 2.
 - 2. Single-Mode: Manufacturer type, fiber counts, part numbers, and comcodes specified in Table 2.
- C. Termination Components: Specified in Table 2. Substitutes shall not be accepted.

2.03 LABELS

- A. General: Refer to “Labeling” Article in Part 3 for label information.
- B. Intra-Building and Inter-Building Cables: Twisted pair copper cable, optical fiber cable. Label each cable at each end with unique identifier.
 - 1. Use portable labeling system printer, Brady LS2000 or approved equal.
 - 2. Mark each cable with shrinkable wire marker sleeve. Do not shrink sleeves.
- C. Copper Cable 110 Wiring Units: Floor-standing frames and wall-mounted 110 wiring blocks, 100 or 300 pair.
 - 1. Provide each frame- or wall-mounted cabinet housing, 110 blocks with engraved quality (ABS) plastic label.
 - 2. Contact SNL/NM Telecommunications Operations Department for pre-assigned frame/block layouts before terminating or labeling cables.
- D. Lightguide Interconnection Unit (LIU): Provide each LIU with engraved quality (ABS) plastic label.
- E. Telecommunication Cabinet: Floor-standing cabinet and wall-mounted cabinet. Provide each cabinet with engraved quality (ABS) plastic label.
- F. Lightguide Termination Shelf: Each cable terminated to termination shelf shall be labeled on outside of shelf door.
 - Use portable labeling system printer, Brady LS2000 or approved equal.
- G. Backbone Conduit Pullbox: Provide each pullbox with engraved quality (ABS) plastic label. See Appendix A, Figure 11 for label specification and sequence of information.
- H. Conduit: Provide each conduit end point with Panduit, #PLM4S-C tie wrap label tag or approved equal.

2.04 INTRA-BUILDING TELECOMMUNICATION TEST EQUIPMENT

- A. Test Equipment: Twisted pair cable and optical fiber cable.
- B. Refer to Table 3 for Sandia-preferred test equipment.
- C. If Testing Contractor chooses to substitute test equipment different from Table 3, provide submittal accompanied with appropriate technical data for approval prior to use.
- D. Testing Contractor shall record downloadable software revisions in Outlet Cable Test Form (Appendix B).

PART 3 - EXECUTION

3.01 GENERAL

- A. Consult with SDR to verify areas that are permit-required confined spaces as defined in OSHA 29 CFR Parts 1910. Comply with requirements of OSHA 29 CFR Parts 1910 when working in permit-required confined spaces.
- B. Locations of hazardous materials areas are shown on Drawings.
 - 1. Avoid disturbance of hazardous materials in making acceptable modifications of raceway routing, mounting of equipment, and other work.
 - 2. Do not mount conduit, equipment, hangers, and other accessories on surface materials known to contain asbestos or other hazardous materials without written authorization from SDR outlining method of installation.
 - 3. If hazardous materials or conditions not shown on Drawings are encountered, stop work immediately and vacate area.
 - a. Immediately notify SDR of condition encountered.
 - b. Do not enter area or work in area until receiving written authorization from SDR.
- C. Do not install damaged or defective components.
 - 1. If SFM are found to be defective, immediately report problem to SDR and provide documentation with sufficient engineering data to confirm defect.
 - 2. Contractor shall receive replacement SFM materials only after defective materials have been returned to SDR and defect has been confirmed.
 - 3. SFM that are rendered unusable due to Contractor error or improper installation as determined by SDR, shall be replaced at Contractor's expense.
- D. Conduit entrances into IDR or technical control center (TCC) shall be perpendicular to cable tray (or ceiling).

Do not use horizontal conduit entrances, unless pre-approved by SDR in writing. Special measures to protect cabling must be undertaken in this case, at the direction of SDR.
- E. Ensure that existing conduits are clean and free of obstructions prior to pulling cable. Install ground bushings on conduits where required before pulling cable.
- F. Secure products in place with positive anchorage devices, designed and sized to withstand stresses, vibration, and distortion.
- G. Prepare as-built documentation beginning at Project start date.

3.02 INSPECTION

- A. Existing Buildings or Remodeling Projects: Do not begin Work on site, or provide submittals until detailed inspection of existing site has been performed, and site investigation report has been submitted. Verify the following:
 - 1. Information presented in Contract documents is correct.
 - 2. Installation of equipment and work can be accomplished as shown in Contract documents.
 - 3. Contractor's proposed installation equipment and methods are compatible with existing conditions.
 - 4. Take field measurements and record other data required for preparation of shop drawings and other submittals.

- B. Variations: Drawings and other Contract documents indicate basic location, arrangement, and routing of equipment and components.
 - 1. Submit detailed description of proposed improvements and modifications to SDR for review that include: Drawings, manufacturer's literature, and detailed description of functional improvements.
 - 2. Do not proceed with incorporation of modifications and associated work until receipt of written approval from SDR.

- C. Site Investigation Report: Prepare written report describing site investigation. Indicate noted conflicts between Contract documents and site investigation information, and include following:
 - 1. Proposed modifications and reasons for change.
 - 2. Specification sheets and written functional requirements to support findings.
 - 3. Drawings and other data required to show variations and corrections.
 - 4. Associated costs to accommodate existing site conditions.
 - 5. If SDR determines work schedule is affected through information presented in site investigation report, Contractor will be notified by SDR. Contractor shall revise initial progress schedule and resubmit to SDR for review and approval.
 - 6. Certify that site investigation has been performed, and that:
 - a. Except for items noted, conditions shown and described in Contract documents are correct.
 - b. Equipment can be installed, and Work can be performed as specified without conflicts with existing site conditions.

3.03 CABLE INSTALLATION

- A. Install system components and appurtenances in accordance with manufacturer's instructions, as described in Contract documents, and as shown in Drawings.
- B. Install in accordance with NFPA 70.
- C. Horizontally- and Vertically-Installed Cable
 - 1. Do not use cable lubricant.
 - 2. Plan cable pulls so that maximum number of cables required in conduit are pulled simultaneously.
 - 3. Route cables via conduit and pullboxes, identified and as shown.
 - 4. EUTP cable length shall not exceed 90 meters (295 feet) from IDR termination frame to user outlet. If run length exceeds this distance, notify SDR. Do not place cable until directed to do so by SDR.
 - 5. If deviations from Drawings are required, they shall be approved by SDR prior to placement of affected cables.
 - 6. Do not install more cables in conduit than shown on Drawings, unless approved in writing by SDR.
 - 7. If indirect attachments are used, match grip diameter and length to cable diameter and characteristics. Reduce pulling forces to ensure that optical fibers and twisted pair conductors are not damaged from forces being transmitted to strength member.
 - 8. Do not exceed maximum tension specified by cable manufacturer.
 - 9. Mechanical stress placed upon cable during installation shall be such that cable is not twisted or stretched.
 - 10. Inspect cable jacket carefully for defects as cable is played off reel.
 - 11. Take precautions during installation to prevent cable from being kinked, crushed, or being mishandled.
 - 12. Do not exceed minimum bend radius of cable as recommended by manufacturer. Contractor is responsible for determining minimum bend radiuses for cable being placed, using manufacturer's latest information. 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)

13. Vertical Cable Runs: Use gravity to assist in cable placement.
 - a. Start installation from top of run to bottom of run.
 - b. Hand-pull if possible.
 - c. If machine assistance is required, monitor tension and do not exceed manufacturer's specified cable tension limits.
- D. Service loops shall be as shown on Drawings.
- E. Installation cable slack requirements are intended to minimize cable waste. After installation, cable slack shall be as shown on Drawings. If not shown, provide pre-termination cable slack as indicated below.
 1. Optical Fiber Cables (prior to termination)
 - a. User Outlet: Not less than 1.5 meters (5 feet), or more than 2 meters (6.5 feet)
 - b. LIU: Not less than 2 meters (6.5 feet), or more than 2.5 meters (8.2 feet).
 2. EUTP Cables, 4-pair (prior to termination)
 - a. User Outlet: Not less than 1.5 meters (5 feet), or more than 2 meters (6.5 feet)
 - b. IDR Termination Frame: All cables shall be able to reach furthest frame location plus 1 meter (3 feet).
 3. UTP and EUTP Cables, greater than 4-pair (prior to termination)

Not less than 5 meters (16.4 feet) beyond designated termination point.
- F. Cable Placement: Route cables to termination points.
 1. Cable bundles shall be combed and each cable shall run parallel with other cables.
 2. After combing and straightening cables, separate cables into bundles according to routing requirements and termination points.
 3. Secure cable bundles with hook-and-loop cable strap material as listed in Table 2. Do not use cable ties manufactured from hard polymer material, such as plastic or nylon.
 4. Begin to bundle and strap cables within 2 inches (51 mm) of exit from conduit. Apply cable straps to bundles at intervals not greater than 12 inches (305 mm) for entire length of vertical and horizontal run.
- G. Splices: Do not use splices in cabling, unless pre-approved.
 1. Splices shall not be allowed in Category 5 cable.

2. Obtain written approval from SNL/NM Telecommunications Operation Department prior to splicing cable.
 3. Approval will be issued only on a case-by-case basis.
 4. Document splice location and type, as part of as-built and record drawings.
 5. Retest cable after splicing. If cable fails test, notify SDR of problem, and provide proposed procedures to eliminate problem.
 6. Contractor shall correct problem, and retest optical fibers and enhanced unshielded twisted pair conductors that failed test procedures.
- H. Install rack-mounted and wall-mounted termination panels and frames as described in Contract documents.
- I. Install couplers, buildouts, and their support panels for optical connections at both ends of optical cables and for EUTP connections at user outlet.
- J. Install plastic user outlet box, front covers, back panels, and associated user outlet parts.
- K. Cover optical connectors, couplers, and buildouts with clean optical dust caps of appropriate type.

3.04 LABELING

- A. General: Missing or unclear nomenclature shall not be construed as reason for not identifying items, and shall be brought to SDR's attention.
- B. Intra-Building Cables: UTP and EUTP cable, optical fiber cable. Label each cable at each end with unique identifier. See Appendix A, Figure 3A for label specification and sequence of information.
1. Floor designation for horizontal cables, and cables to desktop shall be same as desk top outlet location.
 2. Floor designation for backbone cables, cables from TCC to IDR, and IDR to IDR shall be floor where cable originates from, with origin point being TCC.
 3. Telecommunications Operations Department shall provide numeric sequence information for Projects.

If any of the characters change, with exception of last four, then numeric sequence shall start at 0001.

- C. Inter-Building: Twisted pair copper cables, optical fiber cable. Label each cable(s) at each end with unique identifier that is the same as intra-building cables, except for the following:

Inter-building cable names shall not have building numbers associated with them.

D. Copper Cable 110 Wiring Blocks: Floor-standing frames and wall-mounted 110 wiring blocks, 100- or 300- pair.

1. Wire punched down on 110 wiring block shall be labeled on 110 wiring blocks as individual pairs.
2. Label 110 wiring block pair count using Excel spreadsheet template, along with color transparent plastic strip (SFM) for color-coding. Refer to Appendix A, Figure 1.
3. Voice and data 110 wiring block labels will be distinguished by the following acronyms:

Data Frame Example: 8361FADC

Voice Frame Example: 836FAVC

DT = Data Campus Cable

VT = Voice Campus Cable

DM = Data Backbone Cable

VM = Voice Backbone Cable

DL = Data Network Cable

VP = Voice ISDN Power Cable

DU = Data Horizontal Cable

VU = Voice Horizontal Cable

4. Skip 25th position on each strip of 110 wiring block when wiring 4-pair cable.
5. Provide floor-standing frames with twelve 300-pair 110 wiring blocks. Group of blocks are to be designated as campus cables and/or backbone cables, power cables, network cables, and horizontal voice or data cables. See Appendix A, Figure 2 for layout.
6. Install engraved label on each floor-standing frame. See Appendix A, Figure 3, for label specification and sequence of information.
7. Label network equipment 110 wiring blocks with equipment number, slot, and port number.
8. Insert SFM color-coded plastic slides over 110 block labels. See Appendix A, Figure 1 for color definition.
9. Network equipment cross connects shall be labeled by Telecommunications Operations Department.

E. Lightguide Interconnection Unit (LIU)

1. Attach engraved label to door of LIU. LIU label shall have building number, IDR number, and numeric sequence. See Appendix A, Figure 4 for layout.
2. List cables(s) and room number on LIU along with LIU name. See Appendix A, Figure 5 for layout.
3. Provide continuous numbering sequence for individual fiber. Number individual fiber strands in LIU from 1 through 24, for cables with 24 fiber strands or less. See Appendix A, Figure 6 for layout.
4. Use multiple LIUs for cable with greater than 24 fiber strands, and label sequentially according to number of fiber strands. See Appendix A, Figure 7.

- F. Telecommunication Cabinet: Floor-standing cabinet and wall-mounted cabinet.
 - 1. Floor-standing cabinet label shall have building number, color designation for classification of network, IDR number, and sequential character. See Appendix A, Figure 8.
 - 2. Label red (ISN) and black (IRN/EON) cabinets as two separate systems.
 - 3. Center label at top of front door of cabinet.
 - 4. Sequential character shall start over when any of the other characters change.
 - 5. Label wall-mounted equipment cabinet similar to floor-standing cabinet, except replace IDR number with floor number .
- G. Lightguide Termination Shelf
 - 1. Label cable(s) name on outside door of termination shelf.
 - 2. Single shelf may hold more than one campus, backbone or horizontal cable. Do not split a single cable between shelves. Start numbering sequence from 1 within the shelf, and continue to last fiber strand within that cable, for cable larger than 4 fibers. See Appendix A, Figure 9 for layout.
 - 3. Label each individual coupler on coupler plate with appropriate sequential number for terminating shelves.
 - 4. Each shelf shall contain either single-mode or multi-mode red or black, not both.
 - 5. Install multiple shelves for cables greater than 72 optical fibers. Label sequentially according to number of optical fibers.
 - 6. Label 4-fiber user cables according to number of couplers in the shelf.
- H. Telecommunication Outlet: Red (ISN) and Black(IRN/EON)
 - 1. Telecommunications Operations Department will provide label sticker(s) for both red and black outlets.
 - 2. Attach red or black sticker with preassigned numeric value to outlet cover for appropriate outlet. See Appendix A, Figure 10 for various sticker placement.
 - 3. Attach "Warning" sticker with point of contact information to outside of cover of red outlet, if Tamper Indicating Prismatic Seals (TIPS) are used.
 - 4. Red System Only: TIPS shall be installed by Certified PDS Inspector on any non-inspectable (concealed) conduit connector.
 - 5. TIPS shall be installed on connectors at conduit rough-in, such as before conduit is made non-inspectable by installation of building finishes.
- I. Backbone Conduit Pullbox: Install engraved plastic label to cover of pullbox. See Appendix A, Figure 11.

- J. Conduit: Label conduits with appropriate color-coded tape. Refer to Standard Drawing E-0006STD.
 - 1. Install tie wrap label tag on each conduit end point that terminates in IDR, TCC, or stubbed through floor, ceiling or wall without pullbox.
 - 2. Hand-letter with permanent black ink, in block type letters with clear, legible letters.
 - 3. Match label information to information in nearest J-Box label that conduit leads to.

3.05 TERMINATION OF INTRA-BUILDING TELECOMMUNICATION CABLE

- A. Perform test sample amount of terminations designated by SDR, prior to beginning mass cable termination.
 - 1. Terminate both ends of each type of cable installed. Termination work shall be performed only by a SNL/NM pre-qualified Contractor.
 - 2. Provide terminations and connections in accordance with cable and connector manufacturer's specifications.
 - 3. Test terminated cables and submit test report within one week of performing terminations.
 - 4. Do not proceed with termination of remaining cables until test results have been reviewed and approved by SDR.
- B. Optical Fiber Cables: Terminate both ends of cables. After termination, provide cable slack as shown on Drawings.
 - 1. If not shown, cables shall have the following minimum slack after successful termination.
 - a. One meter (3 feet) slack at user outlets.
 - b. One and one-half meters (5 feet) at LIUs and fiber distribution units.
 - 2. Firmly attach aramid yarn strength members at both ends of cable to prevent pullback damage.
- C. UTP and EUTP Cables: Terminate both ends of cables.
 - 1. After termination, provide cables with enough cable slack for clean dress and to prevent stress and sharp bends on cables.
 - 2. Extra cable slack is not required for 4-pair cables provided that connections pass the required tests and cables are not stressed. Provide cables greater than 4-pair with minimum of 3 meters (10 feet) slack after successful termination. Neatly store slack in cable tray, or fasten to wall adjacent to termination location.

3. Provide T568A 8-position modular, 4-pair EUTP connectors at user outlets, as listed in Table 2.
 4. Terminate 4-pair EUTP cables in IDR on 110 blocks with 110C-4 punchdown clips as shown in Table 2. 110C-4 clips shall skip every 25th pair on 110 punchdown blocks.
 5. Terminate UTP and EUTP cables in IDR on 110 blocks with 110C-4 punchdown clips for data pairs, and 110C-5 clips for voice pairs.
 6. Terminate UTP and EUTP cables with preserved wire pair twists as specified in EIA/TIA 568A.
 7. Termination frame 110 wiring block layouts and corresponding cable names shall be provided to Contractor by Telecommunications Operations Department.
- D. Attach 8-position modular connectors and their slide-in support plates at user outlets into user outlets.

3.06 TESTING OF INTRA-BUILDING CABLING

- A. Use Sandia-preferred test equipment as described in Table 3. Submit equipment specifications for desired alternative to SNL/NM Telecommunications Operations Department for approval prior to use.
- B. Provide personnel, equipment, instrumentation, and supplies necessary to perform testing.
- C. SDR may witness field tests.
- D. SNL shall have the right to perform testing independently from Contractor testing.
- E. Contractor shall pay for retesting and consumables required by unacceptable test results.
- F. Daily Test Equipment Preparation: Properly configure Category 5, EUTP cable test equipment each day prior to testing, and shall include the following:
 1. Verify that test equipment is still within manufacturer calibration warranty period.
 2. Verify that test equipment is set to “auto test”, and proper cable type and associated parameters are selected.
 3. Verify that test equipment’s selected nominal velocity of propagation (NVP) matches cable being tested.
 4. Perform self-test of test equipment to confirm proper function ability.
 5. Connect test equipment to its matched “smart” terminator, and perform auto test to confirm that test equipment and terminator are functioning properly.

- G. Category 5, EUTP Cable Tests: Use EIA/TIA TSB-67 Level 2 tester to automatically perform the following tests.
1. Line Mapping (End-to-End Connectivity). Check 4-pair wiring for proper wiring configuration, open conductors, shorted conductors, crossed pairs, and reversed pairs.
 2. Loop Resistance (DC-Steady State). Connect OHM meter across one end of cable pair with shoring terminator across the other end of cable pair.
 - a. Measure steady-state DC resistance, and compare to cable manufacturer's standard values.
 - b. Values greater than allowed resistance are considered to have failed, and values smaller than allowed resistance are considered to have passed.
 3. Attenuation: Transmit several signals at increasing frequencies across each conductor.
 - a. Measure signal loss in units of decibels (dB).
 - b. Test frequencies and permitted dB loss values at each test frequencies.
 - c. Loss values are specified in EIA/TIA 568A for Category 5, EUTP cable.
 4. Cable Length: Record cable length from either length markings on cable jacket, or from hand-held multi-function test equipment incorporating time-domain reflectometer (TDR) circuitry.
 5. Capacitance: Test each twisted pair with capacitance meter.
 - a. Test opposite end of twisted pair for open circuit.
 - b. Pass test results must yield capacitance within 2 percent of cable manufacturer's specification.
 6. Near-End Crosstalk (NEXT): Measure both outlet and distribution end of link.
 - a. Worst pair of cable with near-end crosstalk must be measured in dB.
 - b. Test frequencies and permitted worst pair dB crosstalk values at each test frequencies are specified in EIA/TIA 568A for Category 5, UTP cable.
 7. Result of each test is either "pass" or "fail".
 8. Repair or replace, and retest failed cables until passing results are achieved.
 9. Complete "Test and Chart Form" to record cable lengths, test data, location, and calculation results. See Appendix B.
- H. Optical Fiber Test Equipment Preparation: Properly adjust optical fiber test equipment prior to use.
1. Follow equipment manufacturer's detailed instruction manual.

2. Calibrate variable unit adjustments on test equipment to match cable manufacturer's cable transmission parameters.
- I. Optical Fiber Cable and Component Test: Use test equipment listed in Table 3, or SNL/NM approved equivalent, and perform the following inspection and test for optical fiber cable. Properly clean optical connector end faces before connector contact is made for testing or circuit connection.
1. Optical Fiber Cable Length Measurement: Record cable length (in feet) from either length markings on cable jacket, or from optical time-domain reflectometer (OTDR) measurements on "Outlet Cable Test Form".
 2. Optical Fiber Connector Validation Test: Inspect each optical fiber connector assembly with 400X visual inspection.
 - a. Reject connector assembly if visible imperfection penetrates fiber core, or if imperfection risks future damage to core or mating connector's surface.
 - b. Reject connector assembly if connect loss displayed by loss test set, or OTDR causes link attenuation to exceed acceptable link attenuation.
 - c. Reject connector assembly if connector reflectance causes link return to exceed acceptable link return loss.
 - d. Replace or repolish rejected connector assemblies, and retest until acceptable measurements are obtained.
 3. Optical Reference Level Measurements
 - a. Connect optical source to power meter with two- to three-meter jumper cables that have identical transmission characteristics as optical link being measured.
 - b. Record optical power levels in dBm after operational stabilization, primarily ambient thermal conditions are reached.
 - c. Repeat procedure during measurement process to verify integrity of optical fiber test jumpers and optical source.
 - d. Record optical source and power meter serial numbers of units used on each outlet cable test form in test equipment section.
 4. Optical Link Attenuation (LA) Measurements: Measure optical LA after both ends of optical fiber have been terminated and mounted into coupler panels.
 - a. Record and measure LA with optical source and power meter.
 - b. Connect source at one end of optical link, and connect power meter to other end.
 - c. Record power received in dB for each wavelength.
 - d. Reverse location of both source and power meter, and repeat test.

- e. Calculate average recorded power levels for each wavelength, and record in dB.
 - f. Complete "Test and Chart Form" to record cable lengths, test data, location, and calculation results. See Appendix B.
5. Optical Link Return Loss (LRL) Measurement: Measure and record optical LRL for single-mode optical links
- J. Progress Reports: Testing Contractor shall submit progress reports as follows for both Category 5, EUTP cables and optical fiber.
1. Submit one copy of completed "Outlet Cable Test Forms" on weekly basis for first four weeks of Project.
 2. Weekly submittals to begin one week after cable termination Work begins.
 3. Group weekly submittals by name of person performing terminations, with company name in miscellaneous note section.
 4. Submittals are due to Telecommunications Operations Department by 4:00 PM Friday, and shall include results from tests performed since time of previous submittal.
- K. Final Reports - Category 5, EUTP Twisted Pair Cables and Optical Fiber: Final reports which confirm that cabling has been tested per SNL requirements shall be delivered within two weeks after completion of installation.
1. Submit one hard copy and one diskette copy of final reports to Telecommunications Operations Department, and provide one hard copy of cabling charts only in each IDR/TCC.
 2. Each report shall include the following:
 - a. Completed outlet test forms bound in 3-ring notebook by order of room number for each IDR, divided by floor, and divided by red (ISN) and black (IRN). See Appendix A, Figure 12 and 13.
 - b. Copies of EUTP and optical test equipment calibration/certification certificates.
 - c. Copies of training certificates for test personnel.
 - d. Written statement ensuring EUTP and optical fiber performance of the entire installation for minimum period of 15 years from the day of acceptance.
 - e. Diskette copy shall be IBM-PC format, 1.44M capacity, labeled with test date, building number, Contractor name, and Contract/job number.
 - f. Telecommunications Operations Department shall furnish electronic templates of documentation forms prior to termination and testing of cable.

- g. Electronic files shall be Microsoft Excel, version according to Telecommunications Operations Department.

3.07 ACCEPTANCE

- A. Acceptance of optical fiber cable calculations are derived with worst case component tolerances. Values represent upper units of acceptability. Typical results should approach manufacturer's published statistical averages.
- B. Worst-case test values, as shown on Appendix B, Optical Fiber Cable Test Forms, are derived from the following formula:

- 1. Worst-Case Acceptable Multi-Mode Optical Link Attenuations: (2 ST® II connectors plus 300 ft. optical cable)

$$=(2 \times 0.55 \text{ dB}) + (0.09 \text{ km} \times 3.4 \text{ dB/km})$$

$$= 1.1 \text{ dB} + 0.31 \text{ dB}$$

$$= 1.41 \text{ dB}$$

1.4 dB for 850 nm

1.2 dB for 1300 nm

- 2. Worst-Case Acceptable Single-Mode Optical Link Attenuations: (2 ST® II connectors plus 300 ft. optical cable)

$$=(2 \times 0.55 \text{ dB}) + (0.09 \text{ km} \times 0.4 \text{ dB/km})$$

$$= 1.1 \text{ dB} + 0.04 \text{ dB}$$

$$= 1.14 \text{ dB}$$

1.1 dB for both 1310 and 1550 nm

- 3. Worst-Case Acceptable Optical Link Return Loss: (2 ST® II connectors plus 300 ft. optical cable)

$$= \mathbf{35 \text{ dB for both 1310 and 1550 nm}}$$

END OF SECTION

TABLE 1
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 2
Intra-Building Cabling Parts List

Item #	Item Description	AT&T/Lucent Part No.	AT&T/Lucent Comcode
1	Rack Mount Optical Dist. Panel for TCC	LST1U-072/7	105 335 871
2	Coupling Panel for LST1U	1000ST (pack of 12)	105 428 486
3	Jumper Retainer for LST1U	JR1A	104 411 277
4	Cable Clamp	CLMP-12A2	106 230 337
5	Wall Mount Optical Termination Panel	200A LIU	105 535 926
6	Coupling Panel for 200A LIU in IDR	10A	104 141 858
7	Vertical Trough for 200A LIU in IDR	2A8	106 295 520
8	Horizontal Trough for 200A LIU in IDR	2A6	106 497 761
9	MM ST Connector	P2020C-Z-125	106 812 274
10	MM ST Coupler	C2000A-2	104 148 028
11	MM Cable - 4 Fiber, Indoor Riser	LGBC-004D-LRX	106 291 008
12	MM Cable - 12 Fiber, Indoor Riser	LGBC-012D-LRX	106 291 073
13	MM Cable - 24 Fiber, Indoor Riser	LGBC-024A-LRX	106 058 142
14	MM Cable - 48 Fiber, Indoor Riser	LGBC-048A-LRX	106 748 775
15	MM Cable - 72 Fiber, Indoor Riser	LGBC-072A-LRX	106 748 791
16	MM Cable - 24 Fiber, Outdoor 3DNX, HX	AT-RT92BT-024	106 331 457
17	MM Cable - 48 Fiber, Outdoor 3DNX, HX	AT-RT92BT-048	106 331 572
18	MM Cable - 72 Fiber, Outdoor, 3DNX, HX	AT-RT92BT-072	106 331 697
19	SM ST Connector	P3020A-Z-125	106 812 258
20	SM ST Connector ("FAT" 127 micron)	P3020A-Z-127	106 812 266
21	SM ST Coupler	C3000A-2	105 271 142
22	SM ST Coupler Buildout Block (LIU)	A3002	106 709 140
23	SM ST Coupler Buildout (LIU)	A3070 - 0 dB	106 795 354
24	SM ST Coupler Buildout (LIU)	A3070B - 5 dB	106 795 362
25	SM ST Coupler Buildout (LIU)	A3070X1 - 7 dB	107 107 140
26	SM ST Coupler Buildout (LIU)	A3070D - 10 dB	106 795 370
27	SM ST Coupler Buildout (LIU)	A3070F - 15 dB	106 795 388
28	SM ST Coupler Buildout (LIU)	A3070H - 20 dB	106 795 396
29	SM Cable - 4 Fiber, Indoor Riser	LGBC-004D-SRX	106 291 016
30	SM Cable - 12 Fiber, Indoor Riser	LGBC-012D-SRX	106 291 081
31	SM Cable - 24 Fiber, Indoor Riser	LGBC-024A-SRX	106 058 167
32	SM Cable - 48 Fiber, Indoor Riser	LGBC-048A-SRX	106 748 783
33	SM Cable - 72 Fiber, Indoor Riser	LGBC-072A-SRX	106 748 809
34	SM Cable - 24 Fiber, Outdoor, 4DNX, BX	AT-3492BT-024	105 929 384
35	SM Cable - 48 Fiber, Outdoor, 4DNX, BX	AT-3492BT-048	105 929 509
36	SM Cable - 72 Fiber, Outdoor, 4DNX, BX	AT-3492BT-072	105 929 624
37	OpitDuct Liner 1" - 3 cell (AMP)	599028-1	
38	EUTP Cable, 4 pr., Riser, 1000 ft. WE-TOTE	1061 004CSL T1000	106 836 950
39	EUTP Cable, 4 pr., Plenum, 1000 ft. REEL-TOTE	2061 004CWH T1000	107 509 135
40	EUTP Cable, 25 pr., Riser, 1000 ft. Reel	1061 025CSL R1000	107 287 484

Item #	Item Description	AT&T/Lucent Part No.	AT&T/Lucent Comcode
41	EUTP Cable, 25 pr., Plenum, 1000 ft. Reel	2061 025AWH R1000	107 369 845
42	UTP Cable, 100 pr., Riser, 1000 ft. Reel	1010 100AGY R1000	106 824 469
43	4-Pair Connecting Block for 110 Frame	110C-4 (packs of 10)	103 801 247
44	5-Pair Connecting Block for 110 Frame	110C-5 (packs of 10)	103 801 254
45	UTP Frame, RED, w/12-110 Blocks	XLBET - Red	107 065 591
46	UTP Frame, BLK, w/12-110 Blocks	XLBET - Black	105 158 182
47	UTP Frame, Bldg Entr, w'Prot. 300pr	XLBET,blk,9-110's	107 256 190
48	UTP Frame, Bldg Entr, W/Prot. 600pr	XLBET,blk,10-110's	107 119 091
49	Protector Units (old "S" type self-heal)-Blk	3C1S (Black)	105 514 756
50	Protector Units ("S" self-heal)-Blk for Voice	4C1S (Black)	104 386 545
51	UTP, 300 pair 110 block	110AW2-300	107 059 917
52	Surface Mount User Outlet, RED including one (4-port) RJ45 insert, and one (8-port) ST insert (Red)	40A1-317	107 190 282
53	Surface Mount User Outlet, BLK including one (4-port) RJ45 insert, and one (8-port) ST insert	40A1-003 (Black)	107 190 290
54	Surface Mount User Outlet, requires RED or BLACK inserts	40A1 (White)	106 358 807
55	RJ45 Insert (4-port) for White Outlet (RED)	M40-RJ45-317 (Red)	107 346 876
56	RJ45 Insert (4-port) for White Outlet (BLACK)	M40-RJ45-003 (Black)	107 346 819
57	ST Insert (8-port) for White Outlet (RED)	M40-ST8-317 (Red)	107 346 926
58	ST Insert (8-port) for White Outlet (BLACK)	M40-ST8-003 (Black)	107 346 918
59	RJ45 Module, T568A	M100BH1-262	106 821 739
60	RJ45 Module, T568A, MPS100 Power SUM	MPS100BH1-262	107-565-764
62	Velcro "One-Wrap" Cable Ties, 200 yd Spool	One-Wrap (Black)	Velcro 179914
63	Equipment Rack 19", RED, 84 in. H	A4-771924-R	(Everest)**
64	Equipment Rack 19", BLK, 84 in. H	A4-771924-B	(Everest)**

NOTE:

1. If desired parts are not shown within this Table, contact SNL/NM Telecommunications Operations Department for parts to be used.
2. Some part numbers and comcodes may require vendor cross-referencing to new Lucent numbers from older AT&T numbers.
3. Outside plant copper cables may now be produced by "Cable Systems International" (CSI), rather than AT&T. Use CSI cable, ANMA filled ALPETH DEPIC (type) - consult SNL/NM Telecommunications Operations Department for additional information.

TABLE 3

Sandia Preferred Test Equipment

Equipment	Manufacturer	Model	Description
Optical Loss Return Loss Test Set	EXFO	FOT-913-12D-32 • Multi-mode	Dual Wavelength 850/1300 nm LED source with ST® connector and InGaAs detector.
	TTC	462L • Single-mode	Dual Wavelength 1310/1550 nm Cooler LASER with HRL faceplate connector and InGaAs detector.
OTDR	TEKTRONICS	• TFP2 FiberMaster	
		FM8513-Option 24 • Multi-mode	Dual Wavelength 850/1300 nm source with ST® PC connector
		FM1315-Option 34 • Single-mode	Dual Wavelength 1310/1550 nm source with ST® PC connector
Optical Interferometer	Norland Products Inc.	Connect-Check	Portable/bench video microscope with interferometer
EUTP CAT 5 Cable Tester	FLUKE	DSP-100 or DSP-2000	Multi-function tester

NOTE:

1. EUTP CAT 5 cable testers shall meet EIA/TIA TSB-67 Level 2 requirements. Known equivalents include Microtest PENTASCANNER, Scope Communications WIRESCOPE 155, and Wavetek LANTEK PRO/PROXL - all with latest available software revisions.
2. Optical cable testers shall have preferred sources and detectors as listed above. Attenuation shall 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 prior to use.