

**SPECIAL SPECIFICATION**  
**SECTION 25081S**  
**QUALITY ASSURANCE AND DOCUMENTATION**

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**PART 1 - GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Section Includes: Testing and documenting for telecommunication cabling terminations at Sandia National Laboratories, New Mexico (SNL/NM).
- B. Drawings shall delineate telecommunications cabling system by locations of Main Distribution Room (MDR) and Intermediate Distribution Room (IDR), user outlets, and rack frame and cabinet locations.

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

- C. Project may contain both Red - Sandia Classified Network (SCN), and Black – Sandia Restricted Network (SRN) and Sandia Open Network (SON) systems.

Red systems require special security procedures. Contact the MESA Protected Transmission System (PTS) Coordinator through the Sandia Designated Representative (SDR) for information supplementing this specification. All work performed on Red Systems shall comply with United States Department of Energy (DOE) requirements, which may or may not be explicitly indicated or noted in the Contract documents.

- D. Project may have Contractor-furnished material and/or Sandia-furnished material (SFM) as detailed in Statement of Work and/or elsewhere in Contract documents.
- 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. Division 1, Section “Descriptive Submittals.”
  2. Division 1, Section “Environment, Safety and Health for construction and Maintenance Service Contracts.”
  3. Division 25, Section “Administration Requirements.”
  4. Division 25, Section “Telecommunications Equipment Rooms”
  5. Division 25, Section “Main Distribution Frames and Service Entrances.”

6. Division 25, Section “Interior Telecommunications Pathways”
7. Division 25, Section “Exterior Telecommunications Pathways”
8. Division 25, Section “Telecommunications Cabling.”

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 specification. Publications are listed as they contain design and technical criteria that are pertinent to Project. Commencement of work shall indicate a working familiarity on the part of the Contractor with each of these standards.
  1. American National Standards Institute (ANSI)
    - Z136.1-1993 American National Standard for Safe Use of Lasers
  2. Telecordia Technologies, Inc. (formerly known as Bellcore)
    - GR-20 Generic Requirements for Optical Fiber and Optical Fiber Cable
    - GR-111 Generic Requirements for Thermoplastic Insulated Riser Cable
    - GR-196 Generic Requirements for Optical Time Domain Reflectometer (OTDR) Type Equipment
    - GR - 198 Generic Requirements for Optical Loss Test Sets (OLTS)
    - GR-409 Generic Requirements for Premises Fiber Optic Cable
    - GR-421 Generic Requirements for Metallic Telecommunications Cables
    - GR-492 Generic Requirements for Metallic Telecommunications Cable

GR-1009	Generic Requirements for Fiber Optic Clip-on Test Sets
GR-1081	Generic Requirements for Field-Mountable Optical Fiber Connectors
GR-1222	Generic Requirements for Fiber Optic Terminators
TR-TSY-000886	Generic Criteria for Optical Power Meters
TR-NWT-000131	Generic Requirements for Network Plenum Cable/Wire
TR-NWT-001137	Generic Requirements for Hand-Held Optical Power Meters

3. Building Industry Consulting Service International (BICSI)

Telecommunications Distribution Methods Manual

LAN and Internetworking Design Manual

Telecommunications Cabling Installation Manual

Customer-Owned Outside Plant Design Manual

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

526-7	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
526-14A	Measurement of Optical Power Loss of Installed Multi-Mode Fiber Cable Plant – OFSTP-14
568-B.1	Commercial Building Telecommunications Standard Part 1: General Requirements
568-B.2	Commercial Building Telecommunications Standard Part 2: Balanced Twisted-Pair Cabling Components
568-B.3	Optical Fiber Cabling Components Standard
569-A	Commercial Building Standard for Telecommunications Pathways and Spaces
570	Residential and Light Commercial Telecommunications Wiring Standard
598	Optical Fiber Cable Color Coding
606	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
607	Commercial Building Grounding and Bonding Requirements for Telecommunications

6. Insulated Cable Engineers Association, Inc. (ICEA)  
S-80-576 Communications Wire & Cable for Premises Wiring
7. Underwriters Laboratories, Inc. (UL)  
444 Communications Cables

### 1.03 DEFINITIONS

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

### 1.04 SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract documents and Division 1, Section “Descriptive Submittals.”
- B. 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.
- C. 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: The General Contractor shall subcontract directly to the telecommunications subcontractor and shall provide certification that the telecommunications subcontractor meets the following requirements prior to beginning work:
  - a. Shall be based in (operates a commercial office in) New Mexico.
  - b. Shall be certified by Avaya, Inc. as a SYSTIMAX® VAR.
  - c. Shall provide installers to install the telecommunications system who are BICSI-certified at the Technician I level, as a minimum, for cable pulling activities.
  - d. Shall provide installers to install the telecommunications system who are BICSI-certified at the Technician II level, as a minimum, for cable termination activities.
  - e. If work within any of the SNL Limited Area boundaries is required, the subcontractor shall have a minimum of two installers who meet the qualifications in item d. above and who additionally are Q-cleared so as to be permitted to perform cable pulling and termination work within those boundaries.
  - f. Shall furnish evidence of past work quality and experience by providing a project list with descriptions of past projects that are similar in size, scope, complexity, and use of hardware. List shall include client name, project manager name, site address, and a current telephone number for each project listed. Project list shall document at least five years of corporate experience in termination of OF and EUTP cable.
  - g. Shall furnish evidence of qualifications and training (copies of training certificates) for proposed on-site personnel who meet criteria c. and d. above. Include documentation verifying at least five years of field experience in OF and EUTP termination and testing.

#### 1.05 QUALITY ASSURANCE

- A. Material and installation shall meet requirements of NFPA 70.
- B. Material, when applicable, shall be approved by a 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 Section 800-6.

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

## 1.06 WARRANTY

- A. The Contractor shall provide its own warranty for a minimum of five years from the date of final acceptance to SNL for all parts and work covered by the SYSTIMAX® 20-year warranty. In the event in-warranty work is required during this initial five-year period, SNL will contact the Contractor for performance under the warranty and it will be the responsibility of the Contractor to further contact Avaya, Inc. concerning provision of supplies or anything else that maybe construed as the responsibility of Avaya, Inc.
- B. The Contractor shall provide a warranty for a minimum of two years from the date of final acceptance to SNL for all parts and work other than those covered by the SYSTIMAX® warranty. If the Contractor's standard warranty is for a period greater than two years, then the Contractor shall provide a warranty of that length.

## 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 and expressly permitted by Contract documents or SDR.
- C. Products will be specified by industry standard names, unless specifically noted otherwise.
- D. Devices and equipment submitted for approval shall be used for the purpose intended. No deviation from SNL requirements and standards shall be permitted.

### 2.02 INTRA-BUILDING TELECOMMUNICATION CABLING AND TERMINATION COMPONENTS

Cabling and termination components shall be installed as described in Division 25, Section "Telecommunications Cabling."

### 2.03 LABELS

Labeling shall conform to Division 25, Section "Administration Requirements."

### 2.04 TELECOMMUNICATION CABLING TEST EQUIPMENT

- A. Test Equipment: Twisted pair cable and optical fiber cable shall be tested after termination.
- B. Refer to Table 1 for Sandia-preferred test equipment.
- C. If Testing Contractor chooses to substitute test equipment different from Table 1, provide submittal accompanied with appropriate technical data as specified in subparagraph 1.04(D) of this specification for approval prior to testing. Use of any unapproved equipment may make Contractor liable for retesting of all cable terminations at no additional cost to SNL.

- D. Testing Contractor shall record data on Outlet Cable Test Forms as provided by SDR. Electronic copies of files, if available, shall be forwarded along with hard copy of test data.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Consult with SDR to verify areas that are confined spaces as defined in OSHA 29 CFR Parts 1910, requiring special permits for access. Comply with requirements of OSHA 29 CFR Part 1910, Section 146 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. Take the following actions:
    - a. Immediately notify SDR of condition encountered.
    - b. Do not enter area or work in area until receiving written authorization from SDR.
- C. Conduit entrances into IDR or Main Distribution Room (MDR) shall be perpendicular to cable tray (and/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.
- D. Ensure that existing conduits are clean and free of obstructions prior to pulling cable. Install grounding bushings on conduits where required before pulling cable.
- E. Secure products in place with positive anchorage devices, designed and sized to withstand stresses, vibration, and distortion.
- F. Prepare as-built documentation beginning at Project start date. SDR will provide assistance in obtaining one set of reference drawings, if needed, for documentation purposes.

### 3.02 CABLE INSTALLATION

System components and appurtenances shall be installed in accordance with manufacturer's instructions, as described elsewhere in Contract documents, and as shown in Drawings. Refer also to Division 25, Section "Telecommunications Cabling." Any deviations from the requirements specified therein shall be brought to the SDR's attention immediately.

### 3.03 LABELING

Labeling shall be as described in Division 25, Section “Administration Requirements.”

### 3.04 TERMINATION OF INTRA-BUILDING TELECOMMUNICATION CABLE

Telecommunications cabling shall be terminated as described in Division 25, Section “Telecommunications Cabling.”

### 3.05 TESTING OF INTRA-BUILDING CABLING

- A. Use Sandia-preferred test equipment as described in Table 1. Submit equipment specifications for desired alternative to the SDR for approval prior to use.
- B. Provide personnel, equipment, instrumentation, and supplies necessary to perform testing.
  - 1. During initial construction before the communications infrastructure becomes a Classified Distributed Information Network (CDIN), any telecommunications contractor personnel who are qualified as stated in section 1.04.C.3 shall be used to perform testing.
  - 2. After the telecommunications infrastructure has been placed into operation as a CDIN, only Q-cleared personnel shall be used for testing, as stated in section 1.04.C.3.
- C. SDR may witness field tests.
- D. SNL shall have the right to perform testing independently from Contractor testing.
- E. Contractor shall incur all costs for retesting and consumables required by unacceptable test results.
- F. Daily Test Equipment Preparation: Properly configure Category 6, 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 6, 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 4pair 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 6 EUTP cable (pending).
  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 6, UTP cable (pending).
  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 1, 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 re-polish 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, i.e. 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. For multimode fiber perform this measurement at 850 nm and 1310 nm. For single mode fiber perform this measurement at 1310 nm and 1550 nm.
    - 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. Record cable lengths, test data, location, and calculation results in electronically readable form.
5. **Optical Link Return Loss (LRL) Measurement:** Measure and record optical LRL for all single-mode optical links. Measure and record optical LRL for enhanced 50-micron optical links if required by 10 Gigabit/40 Gigabit Ethernet standards.
- J. **Progress Reports:** Testing Contractor shall submit progress reports as follows for Category 6, EUTP cables and for optical fiber.
1. Submit one copy of completed outlet cable test forms weekly for the first four weeks of Project. Test form to be used will be provided by the SDR.
  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 the SDR by 4:00 PM each Friday, and shall include results from tests performed since time of previous submittal.
- K. **Final Reports - Category 6 EUTP 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 electronic copy of final reports to the SDR in a disk format (CD, diskette, etc.) agreed to in advance by the SDR. Provide one hard copy of cabling charts only, to be placed in each IDR/MDR.
  2. Each report shall include the following:
    - a. If hard-copy test results are provided, submit completed outlet test forms bound in 3-ring notebook by order of room number for each IDR, divided by floor, and divided by red (SCN) and black (SRN). If electronic-copy test results are provided, submit the same as separate document files with sufficiently descriptive file names to identify IDR room number and security association (red-SCN / black-SRN).
    - b. Copies of EUTP and optical test equipment calibration/certification certificates.
    - c. Copies of training certificates for test personnel.
    - d. Copies of the contractor warranties, Avaya SYSTIMAX® warranties, and any other manufacturer warranties.

- e. Electronic media shall be IBM-PC format, type and capacity as specified by the SDR, labeled with test date, building numbers, Contractor name, and Contract/job number.
- f. SDR will furnish electronic templates of documentation forms prior to termination and testing of cable.
- g. Electronic files shall be Microsoft Excel or Microsoft Word document files, choice and version according to SDR.

### 3.06 ACCEPTANCE

A. 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 manufacturer's published statistical averages.

B. Worst-case test values, are derived from the following formulas:

1. Worst-Case Acceptable Multi-Mode Optical Link Attenuations:

2 LC connectors plus 300 ft. optical cable

$$= (2 \times 0.2 \text{ dB}) + (0.09 \text{ km} \times 3.4 \text{ dB/km})$$

$$= 0.4 \text{ dB} + 0.31 \text{ dB}$$

$$= 0.71 \text{ dB}$$

**0.7 dB for 850 nm**

**0.5 dB for 1300 nm**

2. Worst-Case Acceptable Single-Mode Optical Link Attenuations:

2 LC connectors plus 300 ft. optical cable

$$= (2 \times 0.2 \text{ dB}) + (0.09 \text{ km} \times 0.4 \text{ dB/km})$$

$$= 0.4 \text{ dB} + 0.04 \text{ dB}$$

$$= 0.44 \text{ dB}$$

**0.5 dB for both 1310 and 1550 nm**

3. Worst-Case Acceptable Optical Link Return Loss:

2 LC connectors plus 300 ft. optical cable  
**=45 dB for both 1310 and 1550 nm**

END OF SECTION

**TABLE 1**

## Sandia Preferred Test Equipment

<b>Equipment</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Description</b>
Optical Loss Return Loss Test Set	EXFO	FOT-922-12D or current model • Multi-mode	Dual Wavelength 850/1300 nm LED source with LC connector and InGaAs detector.
	EXFO	FOT-922X- BR23BL or current model • Single-mode	Dual Wavelength 1310/1550 nm Cooler LASER with HRL faceplate connector and InGaAs detector.
OTDR	EXFO FTB-300	FTB-7212D • Multi-mode	Dual Wavelength 850/1300 nm source with LC PC connector
		FTB-7423B • Single-mode	Dual Wavelength 1310/1550 nm source with LC PC connector
Optical Interferometer	Direct Optical Research Co.	Portable or Bench	Portable/bench video microscope with interferometer
	Norland Products Inc.	Portable or Bench	Portable/bench video microscope with interferometer
EUTP CAT 6 Cable Tester	FLUKE	DSP-4000 Series	Multi-function tester

NOTE:

1. EUTP CAT 6 cable testers shall meet EIA/TIA TSB-67 Level 2 requirements (pending).  
Known equivalents are available from Microtest and Scope Communications - 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.