

**BY ORDER OF THE COMMANDER
SPACE LAUNCH DELTA 45**

**SPACE LAUNCH DELTA 45
INSTRUCTION 17-213**



4 SEPTEMBER 2024

Cyberspace

**COMMUNICATIONS ROOMS
INSTALLATION STANDARDS**

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This Space Launch Delta 45 instruction supersedes 45SWI17-213 to provide design guidance for telecommunications rooms and enclosures and for the security of Space Launch Delta 45 (SLD 45) data, voice, and video network infrastructure by implementing Air Force Policy Directive (AFPD) 17-2, *Cyberspace Operations*, and by summarizing applicable telecommunications standards and security measures required for all new construction and facility renovation projects. Adherence to this instruction will ensure compliance with Department of Defense (DoD) physical security and cyber protection requirements. Ensure all records created as a result of processes prescribed in this publication are maintained in accordance with Air Force Instruction 33-322, *Records Management and Information Governance Program*, and disposed of in accordance with the Air Force Records Disposition Schedule located in the Air Force Records Information Management System. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using AF Form 847, *Recommendation for Change of Publication*; route AF Forms 847 from the field through the applicable functional chain of command. SLD 45 Communication & Information Flight Director (SLD 45/SC) has no authority to waive requirements only to submit for a waiver. Submit requests for waivers through the chain of command to the Publication OPR. Where appropriate, deviations from this instruction for facility refurbishments or renovations may be requested waived, with the approval from the SLD 45/SC Director. The use of a name or mark of any manufacturer, commercial product, commodity, or service in this publication does not imply USSF endorsement.

SUMMARY OF CHANGES

This document has been re-organized and re-written for improved readability. Additionally, some subject areas have been expounded upon with useful information that is consistent with and derived from applicable standards.

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1. Guidance.

1.1. **Guidance.** Except where explicitly stated as otherwise and approved by the SLD 45/SC, the standards, instructions, and guidelines summarized herein are applicable to all SLD 45 projects. The SLD 45/SC PM (Space Communications Project Manager) must coordinate with SLD 45 Civil Engineering Squadron (SLD 45/CES) to ensure that all SLD 45 projects comply with the guidelines presented herein, regardless of DoD agency, tenant organization, or sub-organization. There is an appendix of abbreviations and acronyms at the end of this document for clarity.

1.2. **Responsibilities.** The SLD 45/SC project managers (PM) must coordinate with SLD 45/CES on projects to ensure complete and sustainable communications systems are included within all SLD 45 new *Military Construction* (MILCON) and renovation projects. The SLD 45/SC Plans & Implementation team must review telecommunications designs for compliance with applicable standards. When scope gaps are discovered, the SLD 45/SC PM must coordinate with SLD 45/CES and SLD 45/SC contracting officer representatives, as required to close the gaps.

1.3. **Project Guidance.** This instruction outlines communications infrastructure, and telecommunications room (TR) and enclosure requirements applicable to all SLD 45 projects. Adherence to this instruction will assist with ensuring DoD physical security and cyber protection requirements for communication system infrastructure and equipment installations are considered; assist with the inclusion of telecommunications infrastructure planning and design aspects; and aid in compliance with project documentation requirements.

1.4. **Compliance.** All renovation and improvement projects are required to update telecommunications infrastructure per United Facilities Criteria (UFC) 3-580-01 and the guidance summarized herein. Development of communication services and infrastructure that are located on SLD 45 installations and which the SLD 45/SC will assume sustainment responsibility must reference and comply with this instruction and the standards summarized and referenced herein, regardless of the facility owner or tenant.

2. Security and Controls.

2.1. **Physical and Personnel Security.** Physical security controls must be implemented on all DoD facilities in accordance with Department of Defense Instruction (DODI) 8500.1. Physical measures designed to safeguard personnel, facilities, equipment, and data are required to prevent unauthorized access and to safeguard against espionage, sabotage, theft, damage, or destruction. Additionally, inclusion of physical devices or architectures for suppressing fire, controlling humidity, and physically locking and guarding facilities and equipment is required in accordance with DoD 5200.08 "Physical Security Program". Two common physical security controls are summarized below.

2.2. **Electronic Security Systems (ESS).** ESS are defined by DoD 5200.08 as physical security measures designed to safeguard personnel and property through use of electronic systems including, though not limited to: intrusion detection systems, automated entry control systems, and video surveillance.

2.3. Security Forces. Physically located Security Forces personnel may be required to maintain operational or physical security. Coordination between the end user and Security Forces for new facilities (MILCONs) and renovations will ensure applicable security measures are considered.

2.4. Controlled Area Security. Controlled areas, wherein sensitive information (SI) will be stored or wherein SI work occurs, must be designed to include necessary access control measures as per DoD 5200.08. A controlled area extends upward and outward from a specific point, and as designated by a commander or director. Physical access controls must restrict entry to controlled areas including, but not limited to work and computer areas, telecommunication rooms, and telecommunications spaces. Compliance with DoD 5200.08 is mandatory for all projects and organizations.

2.5. Physical Access Control and Keys. Physical controls for SI areas must be implemented to restrict access from unauthorized personnel while only allowing access to approved personnel. Physical controls include programmed and monitored DoD smart card readers, locking devices, and physical keys held only by a unit's security officer. Telecommunications room door keys for TRs containing SLD 45 network equipment must be issued to and maintained directly by the unit security officer who must log and provide issuance to authorized operations and maintenance personnel.

2.6. Escorting Personnel within Controlled Areas. Escorting of temporarily approved personnel must comply with DoDI 8500.01 and local guidance. At no time nor under any circumstance must any person attempt to bypass or test physical access controls. Violations may result in military and or civilian punitive actions.

2.7. Information Security.

2.7.1. Classify. Categorize all system components and stored data according to DoD Manual 5200.01.

2.7.2. System Authorization. All DoD Information System (IS) users must submit a DD Form 2875 System Authorization Access Request. The system administrator and cybersecurity officer will review the specific need to know and grant access according to DoDI 8500.01. DoD IS users are required to access systems only through their own unique user identification and password and must have first completed initial and annual cybersecurity awareness training.

2.7.3. Program Protection. All organizations and projects must include program protection plans according to DoDI 8500.01.

2.7.4. Data Storage and Media Security. Compliance with DoDM 5200.01 is required for all DoD IS, networks, and media used for data storage or duplication. The security and classification of media must comply with DoDM 5200.01 to prevent data spillage, leakage, loss, theft, espionage, or sabotage. Physically store and safeguard all information, regardless of classification, according to the applicable unit Security Classification Guide, as required by DoDM 5200.45. In the case where data becomes compromised due to loss, theft, or negligence, the unit security manager must be informed immediately.

3. Telecommunications System Design.

3.1. **Completeness.** The SLD 45/SC PM must coordinate with SLD 45/CES to ensure telecommunications systems are adequately scoped for all new military construction and renovation and improvement projects. The SLD 45/CS PM must coordinate with SLD 45/CES to ensure the project contractors design and document a complete telecommunications system, as defined by UFC 3-580-01. For renovations, the contractor must update the telecommunications system as required to ensure the facility telecommunications comply with current standards.

3.2. **Description.** Unified Facilities Criteria 3-580-01 describes a telecommunications system as including: telecommunications spaces, pathways, outlets, connector assemblies, cabling and conveyances, telecommunications grounding infrastructure, and installation grounding and bonding for electrostatic discharge protection. This standard telecommunications system design, which is summarized below, must be documented in accordance with the American National Standards Institute (ANSI)/Telecommunications Industries Association (TIA)-606 Administration Standard for Commercial Telecommunications Infrastructure.

4. **Telecommunications Rooms and Enclosures.** Various TRs and spaces may be required for any project. All new and renovation projects must comply with the design requirements within UFC 3-580-01 and other applicable standards summarized below.

4.1. Telecommunications Areas and Enclosure Types. Common telecommunications areas are defined by ANSI/TIA-569 and summarized below for convenient reference.

4.1.1. Entrance Facility (telecommunications). The facility space where outside plant (OSP) voice and data (telecommunications) cabling enters a building.

4.1.2. Entrance Point (telecommunications). The point where telecommunications cabling emerges through an exterior structure, such as a wall or floor, through conduit.

4.1.3. Entrance Room (ER). An area where inter- or intra-facility telecommunications are joined.

4.1.4. Equipment Room. An environmentally controlled area, typically within a building, wherein main and intermediate cross-connects are housed and wherein equipment not normally placed in TRs, such as electromechanical equipment, is located.

4.1.5. Telecommunications Enclosure (TE). An area wherein telecommunications equipment or cross-connects may be located. A TE should not replace a TR, though a TE may be required in certain instances.

4.2. **Telecommunications Room Location and Access.** Telecommunications spaces must comply with the architectural location and access requirements stated within UFC 3-580-01.

4.2.1. Telecommunications Room Placement. For each floor where telecommunications are required, the TR should be situated at a central point to limit the maximum cabling length to no greater than 295 feet (90 m). In larger facilities, TR spaces must be configured so that the distance between the furthest outlet and the serving rack does not exceed 295 feet. In some instances, a main TR with one or more smaller TRs per floor may be required.

4.2.2. Telecommunications Room Equipment. Telecommunications projects must comply with equipment placement requirements as required by ANSI/TIA-568-D. A telecommunications space must only house telecommunications and environmental control equipment and the area must be situated away from potential electromagnetic interference (EMI) sources including power transformers, motors, generators, and radio transmission sources.

4.3. Telecommunications Room Sizing and Design. The minimum size of any TR situated in DoD buildings is 10 feet x 8 feet, as per UFC 3-580-01. TR sizing and design requirements are detailed within ANSI/TIA-568D and UFC 3-580-01, summarized below for convenience. Per industry standards a minimum of 3 feet front clearance and 2 feet rear clearance must be provided from the rack surface outward (cite: TIA-569-E, 6.3.9.3).

4.3.1. General. The general space required for TRs is 1.1 percent of the area served, as detailed in UFC 3-580-01. For example, for a 10,000 square foot area (929 square meters), the TR should be no less than 10 feet x 11 feet (3 meters x 3.4 meters).

4.3.2. Serving Areas. At a minimum, one TR should be provided per floor. Additional TRs must be implemented when floors are greater than 10,000 square feet, or to prevent cable distance between outlets and racks from exceeding the 295 feet (90 meters) maximum cable distance specified in UFC 3-580-01.

4.3.3. Command and Control. For facilities wherein extensive telecommunications are required, such as command and control facilities, the TR space required should be adjusted to 2.0 percent of the area served.

4.3.4. Air Conditioning and Equipment. When TRs must house Heating, Ventilation and Air Conditioning (HVAC) or other equipment, the TR size must be correspondingly increased, as described within UFC 3-580-01. Telecommunications HVAC requirements are discussed further in Section 4.6, below.

4.3.5. Additional Design Limitations. Compliance with UFC 3-580-01; National Electrical Code (NEC); and ANSI/TIA-569 is required for TR designs. Avoid irregular TR shapes and ensure adequate access to TRs for sustaining activities such as equipment delivery and maintenance. Position TRs away from other building areas that would limit future expansion.

4.3.6. Exceptions. Exceptions from the above stated sizing requirements may be necessary for small, non-standard, or mixed-use facilities that are unable to comply with UFC 3-580-01, ANSI/TIA-568, and ANSI/TIA-569, which advise against smaller TRs. Exceptions from the standards must be approved, with SLD 45/SC *Plans & Implementation team* concurrence or by the SLD 45/SC Director.

4.4. Telecommunications Room Floors, Walls, and Ceilings. Design TR floors, walls, and ceilings in accordance with ANSI/TIA-569 and as summarized below.

4.4.1. Floor Loading. The SLD 45/SC PM must coordinate with SLD 45/CES to make sure the structural engineers ensure floor loading meets requirements as required by ANSI/TIA-569.

4.4.2. Floor Materials. Floors installed in TRs and spaces must comply with the electrostatic discharge requirements required by ANSI/TIA-569.

4.4.3. Ceilings. Ceilings must not be installed in TRs, rather, the TR walls must extend to the utmost roof or ceiling line. The minimum distance (height) between the TR finished floor and the ceiling's lowest point is 10 feet (3 meters), while a greater distance is required to accommodate lighting fixtures, rack heights, cable conveyances, and maintenance. The TR must be dimensioned to allow 8 feet (2.4 meters) minimum clearance distance (height) above equipment, such as TR racks.

4.4.4. Windows. Windows are not permitted in TRs, as per UFC 3-580-01.

4.4.5. Doors. Doors and accesses into TRs must comply with the dimension and access requirements detailed in ANSI/TIA-569. Doors should not open inward and should allow for equipment deliveries. Louvered doors are not acceptable for TR areas accessed from building exteriors. The American Disabilities Act must be complied with for entry ways and passageways between TR equipment.

4.5. Utilities for Telecommunications Spaces.

4.5.1. Telecommunications Lighting. Lighting must be installed in TRs and ERs in accordance with UFC 3-530-01, Interior and Exterior Lighting and Controls.

4.5.2. Lighting Fixtures. The placement of lighting fixtures must be in the aisle ways and situated to not interfere with rack or conveyance maintenance. The placement of lighting fixtures must not be singular in the TR, there must be multiple lighting fixtures that serve dual purposes. The example is there will be multiple fixtures overhead (dispersing light from ceiling downward) across the length of the TR. There must also be fixtures horizontally mounted on the side walls at key points to illuminate work surfaces (such as the face of an equipment rack or the mounting surface of a telecom backboard).

4.5.3. Lighting Power. Lighting installed in TR and ER spaces must receive electrical power from an electrical distribution panel that is separate from the telecommunications equipment electrical power distribution panel.

4.5.4. Lighting Performance. Lighting must provide a target horizontal illuminance of 500 lux (minimum +/- 10%); and a target vertical illuminance of 200 lux (minimum +/- 10%). Uniformity in measured vertical illuminance is required, as measured from five feet above ground; and as measured horizontally in the aisle ways between cabinets and racks.

4.5.5. Telecommunications Electrical Power. Electrical power must meet the minimum requirements stated within UFC 3-580-01. Coordinate with UFC 4-021-02, ESS when the user requires security systems. The SLD 45/SC PM must verify user requirements will be satisfied and the minimum requirements summarized below.

4.5.6. Dedicated Electrical. A dedicated electrical branch circuit panelboard must be installed for each TR with the following specifications: 120/208 volt, 3-phase, 100 amperes (A or Amps) minimum bus rated capacity, 24 space panel; or 120/240 volt 1-phase, 100 A minimum bus rated capacity, 20 space panel. All TR loads, excluding lighting, must be fed from the dedicated panel. Dedicated electrical branch loads must include, though are not limited to convenience receptacles, rack and cabinet receptacles, and HVAC systems, including split systems with exterior units.

4.5.7. Convenience Receptacles. Install 125 volts alternating current (VAC), 20 A minimum duplex convenience power receptacles at no less than 6 feet (1800 mm) intervals, on center, on every perimeter wall within the TR.

4.5.8. Emergency Power. Install emergency backup power, with automatic switchover capability, to TRs and enclosures, as required, to maintain servers and communications equipment, in accordance with ANSI/TIA-606.

4.5.9. Emergency Receptacle. Provide at least one duplex electrical outlet supported by an emergency backup power source, to support emergency maintenance.

4.5.10. Electrical Power Outlet Strips. Install, at a minimum, two multi-outlet power strips in each TR rack and cabinet in compliance with UFC 3-580-01. Within each rack and cabinet, ensure that one power strip is fed from the 240 VAC or 208 VAC source (1 phase) (dependent upon the TR electrical panelboard configuration used); the second power strip must be powered from a 120 VAC circuit (1 phase). Power strips must include power indicators (i.e., LEDs), but no on/off switch, to minimize accidental power-offs. The receptacles, which are fed from the dedicated TR electrical panelboard circuits described above, must be matching twist lock type configurations, approved by National Electrical Manufacturers Association. Mount the twist lock receptacles above the racks and cabinets, to the telecommunications cable tray or ceiling space.

4.5.11. Electronic Security. If required by the using activity, install a dedicated 125 VAC, 20 A circuit on the wall directly above the entry door, to satisfy the ESS requirements required by UFC 4-021-02 ESS.

4.5.12. Considerations. The contractor must determine the unique power requirements for each rack and cabinet, and when required, additional power outlets must be installed, in compliance with UFC 3-530-01 and ANSI/TIA-569.

4.5.13. Unused Equipment. Racks and cabinets with no equipment (i.e., empty racks) nor equipment expansion plans, do not require power strips, as per ANSI/TIA-569.

4.6. Telecommunications Heating Ventilation and Air Conditioning.

4.6.1. Telecommunications Environmental Controls. In accordance with ANSI/TIA-606, when emergency (standby) power is available to the entire building, then the HVAC should also be equipped with emergency (standby) power and the telecommunications room must have no window – to eliminate the bad effects of outside light (sunlight) on the equipment within.

4.6.2. Telecommunications Rooms and Enclosures Climate Control. Telecommunications spaces must be equipped with HVAC that can operate 24 hours per day and 365 days per year. If the building system HVAC will not provide continuous operation for TR spaces and TR equipment, then a standalone unit must be provided in the overall facility design for all TR spaces and for TR equipment climate control. The temperature and humidity must be controlled to provide continuous operating temperatures between 64°F to 81°F while maintaining 60 percent maximum relative humidity per ANSI/TIA-569-D. Humidification and dehumidification equipment may be required, depending upon the local environmental conditions. For critical SLD 45 facilities, the TR HVAC system must be connected to a facility uninterruptible power supply or generator.

4.6.3. Telecommunications Rooms and Enclosures Contaminants Protection. A positive pressure differential, with respect to surrounding areas, must be provided for dust control. Telecommunications equipment and telecommunications spaces must be situated away from contamination sources such as moisture, liquid, gaseous spillage, and dust.

4.7. Telecommunications Rooms and Spaces Components. Provide telecommunications designs which are compliant with the latest revisions of applicable DoD instructions and standards, or as specified by the customer. Always reference and comply with the latest versions of DoD instructions and industrial standards.

4.7.1. Telecommunications Rooms and Enclosures Plywood Backboards. Cover a minimum of two adjacent walls with rigidly fixed ¾-inch (20 mm) minimum thickness; A/C grade (e.g., finished front/unfinished back) plywood, as required by ANSI/TIA-569. The plywood must be in 4-foot by 8-foot sheets and positioned at least 8 feet high against each adjacent wall from 8- inches above the finished floor. If to be painted, then the plywood must be finished with two coats of fire-retardant light-colored paint, prior to installation.

4.7.2. Telecommunications Rooms and Enclosures Building Entrance Terminal. Entrance terminals must be equipped to protect against power surges, as required by UFC 3-580-01. Provide 110-type insulation displacement contact (IDC) terminal blocks or cable stubs.

4.7.3. Telecommunications Rooms and Enclosures Equipment Racks. Provide a minimum of 19 inches (475 mm) floor mounted equipment racks, positioned in accordance with National Fire Protection Agency (NFPA) 70, National Electrical Code for adequate clearance between racks.

4.7.4. Telecommunications Equipment Racks Clearance. The NFPA 70 requires a minimum of 36 inches (900 mm) space both in front and behind each rack, as measured from the equipment. The space between all live circuit components, walls, and any obstructions must be no less than 36 inches to allow adequate space for maintenance and safety. The clearance between rack sides must be no less than 24 inches (600 mm). When racks are installed adjacent to other racks, there must be a no less than 24 inches clearance between the wall and the rack.

4.7.5. Telecommunications Equipment Racks Installation. All floor mounted telecommunications and equipment racks must be secured to the floor using bolt anchor kits. TAPCON® screws are not authorized for securing or anchoring racks or cabinets.

4.7.6. Telecommunications Equipment Racks Electrostatic Isolation. Rack isolation kits must be installed to isolate all open frame racks from conductive flooring.

4.7.7. Telecommunications Rooms and Enclosures Equipment Cabinets. Cabinets may be installed in lieu of racks when required by specific service requirements, where physical security is required, and where separately controlled access is desired. Cabinets must be a minimum of 24 inches (600 mm) wide and be configured with cooling fans.

4.7.8. Telecommunications Equipment Cabinets Clearance. The NFPA 70 requires a minimum of 36 inches (900 mm) space both in front and behind each cabinet, as measured from the equipment. The space between all live circuit components, walls, and any obstructions must be no less than 36 inches to allow adequate space for maintenance and safety. The clearance between cabinet sides must be no less than 24 inches (600 mm). When cabinets are installed adjacent to other racks or cabinets, there must be a no less than 24 inches clearance between the wall and the rack or cabinet.

4.7.9. Telecommunications Equipment Cabinet Installation. All floor mounted telecommunications and equipment cabinets must be secured into position to the floor using bolt anchor kits. TAPCON® screws are not authorized.

4.7.10. Telecommunications Equipment Cabinet Electrostatic Isolation. Cabinet isolation kits must be installed to isolate all equipment from conductive flooring.

4.8. **Telecommunications Cable Management.** All overhead cable management will consist of ladder racks and cable trays, as required by UFC 3-580-01, and as further defined below. Vertical cable management panels must be no less than 6 inches (150 mm) wide.

4.8.1. Telecommunications Rooms and Enclosures Cable Trays. Ladder type or welded wire cable trays must be installed for the management of all telecommunications cable within TR spaces. The initial cable tray maximum fill ratio should be no greater than 25 percent and the final sustaining maximum fill ratio must not exceed 50 percent. The maximum fill depth of any cable tray is 6 inches (150 mm).

4.8.2. Telecommunications Rooms and Enclosures Unshielded Twisted Pair Patch Panels. Utilize 19-inch (475 mm) or 23-inch patch panels in telecommunications installations. Each panel must consist of front-mounted 8 position, 8 contact (8P8C) RJ-45 modular jacks with rear mounted 110 type IDC. The patch panels must be category 6 (CAT 6) or higher. Substandard deviations require SLD 45/SC Director approval.

4.8.3. Unshielded Twisted Pair Patch Panel Wire Management. Each CAT 6 rated patch panel must be installed with separate above and below wire-management hardware affixed to the front of each panel. Strain relief hardware must be installed at the rear of each patch panel.

4.8.4. Unshielded Twisted Pair Patch Panels Spares. Allow a spare capacity of no less than 25 percent within each patch panel, cabinet, and rack to allow for sustainment.

4.8.5. T568B Jack Pin and Pair Configurations. Common communication components must be CAT 6 rated. For existing facilities, common communication components must be CAT 6 rated and must be wired to the T568B configuration.

4.8.6. Telecommunications Rooms and Enclosures Fiber Optic Patch Panels. Fiber optic patch panel connectors must conform to the type and configuration used in existing systems.

4.8.6.1. New Fiber Optic Patch Panels Unclassified. For all new installations, utilize LC or SC type connectors on unclassified patch panels.

4.8.6.2. New Fiber Optic Patch Panels Classified. Only type SC connectors may be installed in classified fiber optic patch panels.

4.8.6.3. **New Fiber Optic Strand Termination.** Terminate all new fiber strands to the equipment rack patch panels using the connector types identified above for each system classification.

4.8.7. **Outside Plant Fiber Secure Cabinets.** All outside cable plant fiber entering the facility must be installed within a secure and lockable cabinet. At a minimum, a low profile, three rack unit wall mount cabinet must be utilized. Lockable fiber wall mounted panels are not acceptable.

4.8.8. **Telecommunications Termination and Hardware.** Connecting hardware used for Unshielded Twisted Pair (UTP) cabling must be installed to minimize signal distortion by preserving wire pair twists as close as possible to the point of mechanical termination. The amount of untwisting in a pair, because of termination to connecting hardware, must be no greater than ½-inch for CAT 6 cables.

5. Telecommunications Pathways. All telecommunications pathways, pathway supports and components design, and installation must comply with the UFC 3-580-01; United Facilities Guide Specifications (UFGS) Division 27 Building Telecommunications System Cabling System standards; and the NECA/BICSI 568, Standard for Installing Commercial Building Telecommunications Cabling. Certified Building Industry Consulting Service International (BICSI) installers must follow BICSI installation practices and methodologies as detailed in NECA/BICSI 568.

5.1. **Backbone Telecommunications Pathways.** Install the facility telecommunications backbone distribution system as required by UFC 3-580-01, and as summarized below.

5.1.1. **Telecommunications Pathways Intra-building Backbone Conduit between TRs.** Utilize a minimum of three 4-inch conduit sleeves to route telecommunications cabling between TRs on separate floors (levels). Vertically align and stack conduit between each telecommunications space.

5.1.2. **Facility Backbone Cable.** The facility equipment room, entrance facility, and telecommunications spaces must be connected to the backbone pathway with adequately sized conduit and raceway systems as practical for each individual installation.

5.1.3. **Facility Backbone Materials and Fill.** All conduit and raceway materials and fill ratios must comply with the UFC 3-580-01.

5.1.4. **Facility Backbone Fiber Optic Considerations.** Based on the size of the backbone pathway, it may be necessary to install fiber optic cabling between distribution points.

5.1.5. **Backbone Installation Method.** Backbone systems must utilize a hierarchal star topology with no more than two levels of cross-connects to reach the highest level (i.e., main cross- connect, intermediate cross-connects, and horizontal cross-connects are acceptable).

5.2. **Horizontal Telecommunications Pathways.** Install the facility telecommunications horizontal distribution system, as required by UFC 3-580-01, and as summarized below.

5.2.1. **Horizontal Backbone Installation Method.** All copper and fiber optic cable designs and installations must comply with ANSI/TIA 568-D and ANSI/TIA 569-D. All cabling runs must have one end terminated to the wall outlet and one end terminated to the appropriate patch panel utilizing a hierarchal star topology.

5.2.2. Horizontal Backbone Supporting Hardware. Provide end-to-end support for horizontal wiring by utilizing the necessary quantity and spacing of D-rings, J-hooks, saddlebags, cable trays, and ladder racks to support the required quantity and length of cable to be installed. Provide no less than 10 feet of slack at the rack or patch panel termination point to facilitate future sustainment.

5.2.3. Individual Copper Cabling Separation from Power. All single copper cables that are not enclosed in metallic conduit or ducts must be installed with no less than 8 inches of separation between parallel (adjacent) power cabling (including conduit containing power cabling). All copper cable bundles that are not enclosed in metallic conduit or ducts must be installed with no less than 12 inches separation from parallel (adjacent) runs of conduit containing power cables.

5.3. Telecommunications Pathway Components. All telecommunications pathway components materials and design must comply with UFC 3-580-01; UFGS Division 27 Building Telecommunications System Cabling System standards; and the NECA/BICSI 568 Standard for Installing Commercial Building Telecommunications Cabling.

5.3.1. Telecommunications Pathways Cable Trays. Solid bottom, slotted bottom, or welded wire cable tray (ladder) must be used to provide a centralized cable management and distribution system. Provide 1 square inch (650 sq mm) cross-sectional area of the tray or wire-way for each outlet location served. Cable trays must be designed to accommodate a maximum calculated fill ratio of 50 percent to a maximum inside depth of 6 inches (150 mm).

5.3.2. Telecommunications Pathways Cable Tray Bonding. All metallic cable trays must be bonded to the ground busbar. Each individual section of the cable tray run must be bonded together utilizing Underwriters Laboratories (UL)-rated splice and/or double bolted hardware. Painted ladder rack systems require the removal of paint at contact location, to achieve a bare metal bond.

5.3.3. Telecommunications Pathways Ladder Style Trays. Do not use ladder cable trays for horizontal distribution due to possible cable deformation caused with large cable quantities.

5.3.4. Telecommunications Pathways Cable Tray Sustainment. Provide 12 inches of clearance above cable trays for sustainment. Designers must coordinate with other disciplines to ensure clearances can be achieved.

5.3.5. Telecommunications Pathways Enclosed Ducts (Raceways). When a building design does not provide for installation of cable trays, enclosed square ducts may be installed. Enclosed ducts may also be used in place of cable trays when cable plant requires physical security. For initial design guidance, provide 1 square inch (650 sq mm) of cross-sectional area of the enclosed duct per outlet location. During actual design, the designer must plan for an optimal maximum fill ratio of 40 percent. A fill ratio of 50 percent must never be exceeded.

5.3.6. Telecommunications Pathways Enclosed Ducts Sustainment. Provide 12 inches (300 mm) of clearance above cable trays for future access, as per ANSI/TIA-569-D.

5.3.7. **Non-continuous Cable Supports.** Non-continuous cable supports must not be used in lieu of a cable tray system. Non-continuous cable supports (J-hooks, saddlebags, etc.) must be specifically designed to support category-rated cabling. Supports must never exceed 20 cables or 50 percent of the fill capacity, whichever is less. Spacing between supports must not exceed five feet. Non-continuous cable supports must comply with NECA/BICSI 568.

5.4. **Conduit.** Install no less than 1 inch (27 mm) minimum diameter Electrical Metallic Tubing (EMT) conduit for telecommunications systems outlets. Telecommunications conduit runs must be installed at every location where an electrical outlet is installed in the facility.

5.4.1. **Conduit Electrical Metallic Tubing.** Install EMT conduit from the cable backbone distribution system. The EMT conduit run must be installed extending from the distribution system (cable trays or enclosed ducts) to each individual outlet. Alternately, install the conduit from a receptacle box into an accessible ceiling space directly above the receptacle box (stub- up).

5.4.2. **Conduit Bends.** Each EMT conduit run must be limited to the equivalent of no more than two 90-degree bends. The inside radius of a conduit bend must be at least six times the internal diameter. When the conduit size is two inches (2) or greater, the inside radius of a bend must be at least ten times (10) the internal diameter of the conduit. For conduit wherein fiber optic cabling is installed, the inside radius of a bend must always be at least ten times (10) the internal diameter of the conduit.

5.4.3. **Conduit Fill Ratio.** The UFC 3-580-01 recommends following a maximum fill ratio of 40 percent for telecommunications conduit designs. Under no circumstances must the fill ratio exceed 50 percent. No greater than 4, four-pair cables may be installed in a single 1-inch (27 mm) diameter conduit.

5.4.4. **Conduit Bonding.** Conduits must be bonded to either the Primary Bonding Busbar (PBB) or Secondary Bonding Busbar (SBB), where present, or to the cable tray. Stub-up and stub-out conduits are generally not grounded.

5.4.5. **Conduit Pull Boxes.** Pull boxes must be placed in conduit runs where a continuous conduit length exceeds 100 feet, or where there are more than two 90-degree bends. Pull boxes must be placed in straight runs of conduit and must not be used as a conduit bend alternative.

6. Telecommunications Cabling. Design and install all telecommunications cabling in accordance with ANSI/TIA-568-D. Ensure only CAT 6 or higher, UL-rated, and plenum rated cabling is implemented, in accordance with UFC 3-580-01 and NFPA 70.

6.1. **Telecommunications Cabling Management.** Comply with ANSI/TIA-606 color-coding requirements for cross connect fields and cable plant administration. Only plenum rated velcro cable wraps should be used for cable management. Plastic cable ties (wraps) must not be utilized on any SLD 45 telecommunications project.

6.2. **Telecommunications Cabling Distribution.** Provide for ceiling distribution systems with pathways or openings, such as through beams and other obstructions, to facilitate sustainment activities. Service loop bend radius for vertical and horizontal offsets must be included in cabling installations. The structural engineer must approve structural alterations.

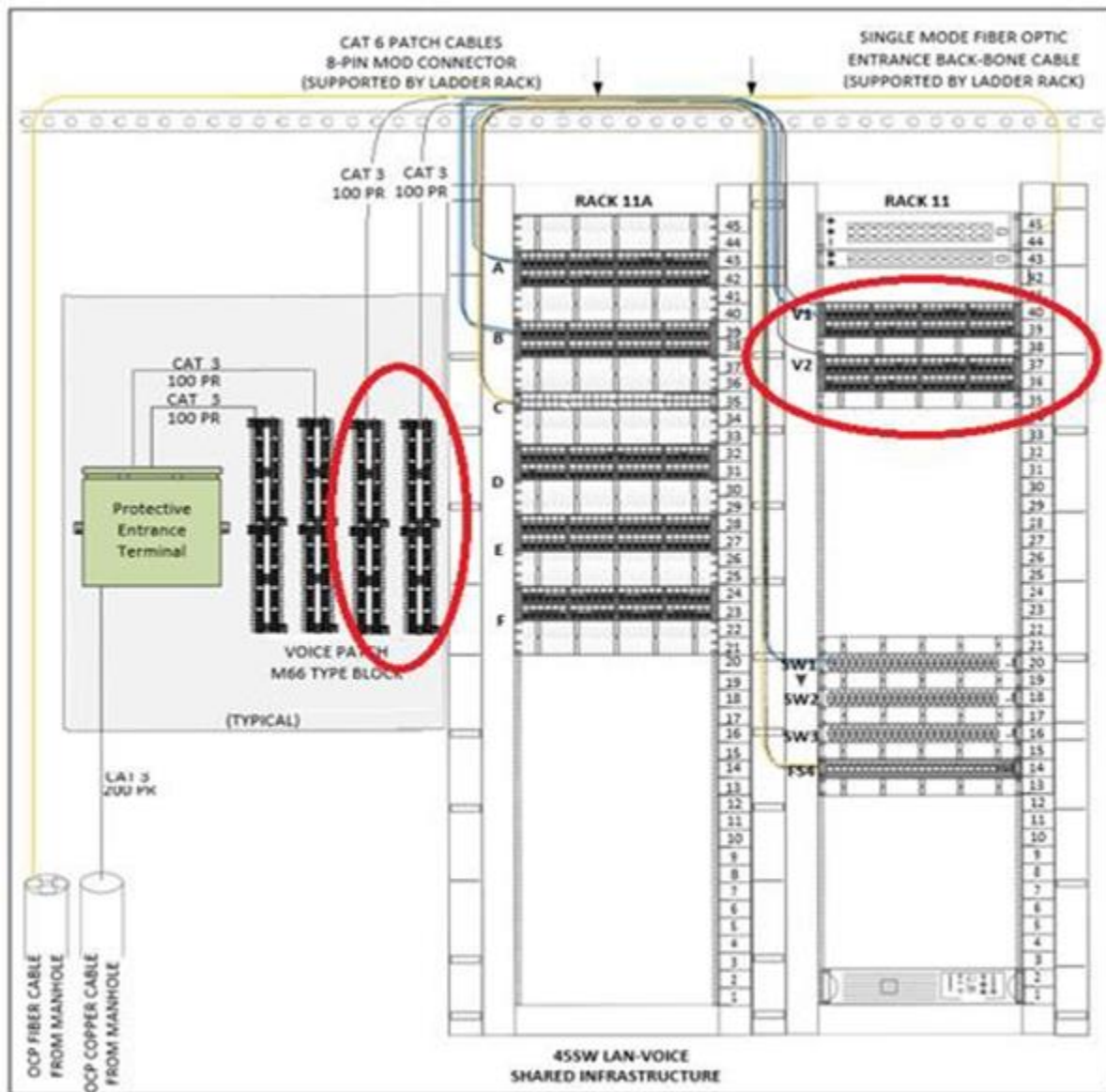
6.3. Telecommunications Cabling Fire Stopping. Firestop all sleeves and slots IAW applicable building codes.

6.4. Telecommunications Cabling Pathway Conduits. Provide an adequate size and quantity of conduits or sleeves for backbone pathways, as determined by the area served by the cable distribution system. Cabling design considerations must include the required interconnections between TRs and enclosures as detailed in ANSI/TIA-569.

6.5. Telecommunications Cabling Backbone Copper. All facility renovations must be configured with CAT 6 or higher rated cabling. New construction horizontal cabling must be four-pair, 100-ohm, UTP, CAT 6 rated and specified to handle transmission speeds of 250 MHz (minimum). The use of Teflon insulated, plenum rated CAT 6 cable is acceptable for both plenum and non-plenum applications. When Teflon-insulated plenum rated cable is used, it must be type 4X0 (type 3X1 and 2X2 are not acceptable). All cable must be level verified and cable jackets must be factory marked at regular intervals with type and performance level identification.

6.5.1. Telecommunications Cabling Copper Termination. All copper pairs must be protected, when required, in accordance with ANSI/TIA-758-B with surge protection for protecting the inside cabling and equipment from power surges. As required by UFC 3-580-01, utilize 110 type IDC terminal blocks or cable stubs. Existing 66 blocks will be utilized (e.g., grandfathered) if the OSP is not modified or relocated. Existing 66 punch down blocks must be bolted to the entrance facility A-C plywood backboard, as shown in [Figure 1](#), below.

Figure 1. OSP to ISP Converged Premise/Horizontal Distribution – an Example.



NOTE: For reference only.

6.5.2. Telecommunications Cabling Horizontal Copper. A minimum of one CAT 6, or higher rated, UTP copper cable must be provided to each 8-pin RJ45 type modular jack. Reference Section 12.0 Identification and Labeling, for labeling requirements.

6.6. Telecommunications Cabling Backbone Fiber. Fiber Optic backbones must implement 9/125-micron single mode fiber optic cable, 150 ohm shielded cabling and connectors, as required by the project, and approved by the SLD 45/SC PM.

6.6.1. Optical Fiber Design. Provide a minimum of 12 strand, single mode, loose buffer tube- type optical fiber cable from the facility entrance point to the nearest fiber service connection point. Install additional optical fiber strands when user requirements necessitate additional networks such as technical datacenters, information transfer nodes, and end building nodes.

6.6.2. Optical Fiber Sustainment. Include a minimum of 15 – 20 feet of slack at each cable end to allow for future sustainment.

6.6.3. Optical Fiber Duct. Install appropriately rated corrugated or fabric inner duct which will help protect and identify optical fiber cabling. Generally, the fiber optic cabling and duct will be at the same rating.

6.6.4. Optical Fiber Connections. In existing facilities, other connector types may be installed to match the current infrastructure when approved by the government telecommunications manager.

6.6.5. Telecommunications Cabling Horizontal Fiber. When mission requirements necessitate, and when approved by the SLD 45/SC PM, provide optical fiber to the required outlets.

6.7. Telecommunications Cabling Exterior. Cable must be provided and installed from the facility entrance point to the nearest copper service connection point. Exterior copper cable must be gel filled, polyethylene insulated conductor cable, and sized according to the square footage of the facility.

6.7.1. Telecommunications Cabling Exterior Sustainment. Include 15 – 20 feet slack at each end of the cable for future service and repair.

6.8. Coaxial Cable Systems. Utilize Radio Guide-11 (RG-11) cable for outside coaxial cable system installations; and use RG-6 cable for inside coaxial cable system installations.

6.8.1. Coaxial Cable System Hardware. Utilize “F” and RJ-45 type plugs and connectors, balance to unbalance adapters, line splitters, couplers, fittings, and wall mounting faceplates as needed.

6.9. Patch Panel Cross Connecting. Position patch panels to allow the necessary cross connections between equipment. Utilize jumper cables, patch cords, and equipment cables that do not exceed 16 feet per channel on horizontal cross connections used for floor distribution. Install only pre-connectorized factory manufactured patch cords to ensure data performance compliance, as per UFC 3-580-01.

6.9.1. Horizontal Cross Connecting. Provide installation locations that limit lengths of jumper cables and patch cords to 33 feet or less. Cables used for horizontal cross connections and work area cords must not exceed 66 feet when used for serving main or intermediate cross connects for building distributions.

7. User Work Areas. This section summarizes work area design and standardization requirements. Reference Section 12.0 Identification and Labeling, for labeling requirements.

7.1. Outlets. The designer must base the quantity of work area network wall outlets on the square footage of the room or area and the type and quantity of network communications equipment. A telecommunication outlet is a quad panel outlet for connecting CAT 6 cables.

7.1.1. Single Telephone or Wireless Outlets. When an area data requirement is limited to telephone or wireless access point equipment, then a single gang single or dual outlet is required. For wireless outlets, wireless access point outlets must have two CAT 6A cables housed in either a single gang faceplate or a surface mount-style configuration.

7.1.2. **Small Area Outlets.** For small office areas (e.g., 8 feet x 10 feet area limited to one user who requires a computer, telephone, and printer), two quad outlets (each served by two cables) must be installed.

7.1.3. **Phone Outlets.** Cabling supporting phones in hallways, TRs, and mechanical rooms require two CAT 6 cables.

7.1.4. **Larger Area Outlets.** For larger office areas assigned to multiple personnel and with typical network equipment requirements, the user must provide the specific network requirements to ensure adequate network connectivity.

7.1.5. **Typical Outlet Quantity.** Cabling systems must include one telecommunications outlet (quad drop) at every location where an electrical outlet is installed. Install the telecommunication outlets opposite from the electrical outlet, where the stud should serve as the physical separation between data and electrical outlets. When no electrical outlets are installed, then a minimum of one telecommunication outlet must be installed at intervals of ten (10) linear feet throughout the office space.

7.2. **Work Area Outlet Faceplates.** All work area outlets must include single gang, four-position RJ-45 type modular faceplates with label areas positioned both above and below the jacks, as shown in [Figure 2.](#), Standard Faceplate Example. A plastic protector must cover each label area. Reference Section 12.0 Identification and Labeling, for labeling requirements.

Figure 2. Standard Faceplate Example.



NOTE: For reference only.

7.2.1. **Work Area Outlet Assemblies.** On all SLD 45 telecommunications projects, install CAT 6 rated wall outlet assemblies with a minimum of four RJ-45 type connectors. All RJ-45 modular outlet jack inserts must be comprised of 8 pin, 8 conductor, 110-type, IDC connectors.

7.2.2. **Work Area Outlet Conductor Termination.** All eight conductors from each cable must be terminated on the corresponding jack with no bridged taps, splices, or split pairs.

7.3. **Work Area Connectors and Adapters.** Install connecting hardware that satisfies the CAT 6 rating performance requirements as summarized in UFC 3-580-01. Qualified hardware will be marked accordingly by the manufacturer.

7.4. **Work Area Systems Furniture.** A minimum of one telecommunications outlet (quad drop) must be installed per single occupancy cubicle.

7.4.1. Work Area Location. Each cable should be located and terminated on one continuous wall or rack.

7.4.2. Work Area Clearance. Maintain a minimum clearance of 5 to 6 inches both above and below all work area outlet connecting hardware for cable and hardware updates. Do not mount connecting hardware near corners or other locations that will restrict physical access. Avoid narrow side walls in work area installations. The designer must document clearances, special sizing, and termination space considerations in the design and specifications.

8. Additional Systems. Additional communications systems must be designed and installed as required by UFC 3-580-01.

8.1. Close Circuit Television Systems. When user requirements necessitate closed-circuit television (CCTV), then install 75-ohm broadband quad-shielded coaxial cable, single-mode fiber optic, or CAT 6 rated plenum cabling, as the specific installation requires. The CCTV cabling must comply with NFPA 70. When fiber optic is installed, then comply with the horizontal and backbone requirements identified within UFC 3-580-01 and summarized in Section 5 and Section 6 herein.

8.2. Community Antenna Television Systems. Community antenna television systems (CATV), also referred to as cable TV, typically consists of 75-ohm broadband quad-shielded coaxial cable (RG-6) and CAT 6 cabling for the transmission of both UHF and VHF signals and data transmitted over category cabling. The cable system must include the necessary connectors, line splitters, couplers, fittings, wall-mounted faceplates, and support equipment required to complete the installation. Some installations may require service provider coordination.

8.3. Cabling Connections. Connect cabling systems from the entrance facility to the user areas. Mark each cable at both ends with the room number and outlet identifier. Reference Section 12.0 Identification and Labeling, for labeling requirements.

8.4. Wireless Access Points. Ensure wireless local area networks, or wireless access points (WAPs), comply with UFC 3-580-01 and Telecommunications Industries Association Telecommunications Bulletin 162-A (TSB 162-A), which recommends CAT 6A or higher twisted pair cabling or OM3 optical fiber cabling, both of which are designed to support higher data rates and the temperature fluctuations experienced with power application. The designer must indicate WAPs on floor plans by using the standard wireless symbol, in red. Reference Section 12.0 Identification and Labeling, for labeling requirements.

8.5. Public Address Systems. Design and install public address (PA) systems in accordance with UFGS 27 51 16 Radio and Public Address System.

8.6. Supervisory Control and Data Acquisition Systems. Supervisory control and data acquisition systems design must be referred to the SLD 45/CES. The system must comply with SLD 45/SC design and installation requirements when connected to the base network.

9. Grounding, Bonding, and Electrostatic Discharge Protection. The design must comply with NFPA 70; ANSI/TIA-607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; and UFGS 26 20 00, Interior Distribution System requirements as summarized below. The telecommunications grounding system design must include all required fault protection grounding, signal reference grounding, and power grounding, as applicable.

9.1. **Entrance Grounding.** Connect all metallic shields and strength members for OSP entering the facility as close to the building ground as practical, as required by NFPA 70.

9.2. **Grounding Separation.** The design must provide separation (isolation) between the different grounding systems within the facility. The electrical and telecommunications designers must coordinate with other disciplines as required to ensure the lightning and fault protection grounds are designed per NFPA 70 and ANSI/TIA-607.

9.3. **Telecommunications Bonding Busbars.** All grounding cables must be attached to bonding and grounding busbars with double bolted hardware. Grounding busbars installed within TRs should be mounted above the overhead ladder rack or in an area that will not create a safety hazard. Reference ANSI/TIA-607 for industry terms commonly interchanged for the telecommunications grounding system.

9.3.1. **Primary Bonding Busbar.** The PBB must serve as the dedicated extension of the building ground electrode system for telecommunications grounding. The PBB is the central attachment point for the telecommunications bonding backbone (TBB) and is required for all facilities with at least one TR.

9.3.2. **Secondary Bonding Busbar.** For larger facilities with more than one TR, both a PBB and SBB is required.

9.4. **Telecommunications Room Grounding.** All SLD 45 telecommunications spaces must be connected to the facility earth electrode system in accordance with ANSI/TIA-607.

9.5. **Lightning Protection.** Comply with NFPA 780, Standard for the Installation of Lightning Protection Systems and Engineering Technical Letter 11-12 (ETL 11-12), Grounding, Bonding, Testing, and Record Keeping for Communications Facilities.

9.6. **Grounding and Bonding Hardware.** All grounding and bonding cables must be attached to bonding and grounding busbars with double bolted hardware connections. All paint must be removed from bonding contact areas prior to affixing grounding hardware. Reference Section 5.3.2 Telecommunications Pathways Cable Tray Bonding, herein, for bonding requirements.

9.6.1. **Grounding Conductor Identification.** Where insulated, all installed grounding cables must be distinctively marked with green insulation as required by ANSI/TIA-607.

9.6.2. **Grounding Conductor Sizing.** Utilize only copper conductors for telecommunications grounding and bonding. The required TBB and Bonding Conductor (BC) sizing must be no less than six American Wire Gauge and must be increased corresponding to the cable length as per ANSI/TIA-607, at 2 kcmil per linear foot of conductor length, up to a maximum size of 750 kcmil. Reference [Table 1](#). TBB and BC Size Requirements by Length for a list of cable length to size requirements detailed in ANSI/TIA-607.

Table 1. TBB and BC Size Requirements by Length.

Linear Length Meters (m)	Linear Length Feet (ft)	Size (AWG)
< 4 m	< 13 ft	6
4 - 6 m	14 - 20 ft	4
6 - 8 m	21 - 26 ft	3
8 - 10 m	27 - 33 ft	2
10 - 13 m	34 - 41 ft	1
13 - 16m	42 - 52 ft	1/0
16 - 20 m	53 - 66 ft	2/0
20 - 26 m	67 - 84 ft	3/0
26 - 32 m	85 - 105 ft	4/0
32 - 38 m	106 – 125 ft	250 kcmil
38 - 46 m	126 – 150 ft	300 kcmil
46 - 53 m	151 - 175 ft	350 kcmil
53 - 76 m	176 - 250 ft	500 kcmil
76 - 91 m	251 - 300 ft	600 kcmil
> 91 meters	> 301 ft	750 kcmil
NOTE: For reference only. Ensure compliance with latest revision of ANSI/TIA-607.		

10. Environmental Risk Avoidance.

10.1. **Flood Prevention.** Telecommunications spaces and enclosures must be located above any threat of flooding and away from water sources, which could present potential water hazards, including restrooms, janitor closets, and kitchens.

10.2. **Fire Protection.** Provide fire protection for TRs and enclosures as required by NFPA 70.

11. Outside Plant. The project must comply with the OSP requirements detailed in UFC 3- 580-01.

11.1. **Outside Plant Underground Service.** An underground service entrance pathway must be provided to support the base distribution system. The underground service entrance pathway must be comprised of 4-inch (or greater) diameter conduits. Provide no less than three (3) conduits from the entrance facility to the nearest service connection point. The exact quantity and size of conduits required for the project must correspond with the total facility square footage, as per ANSI/TIA-569.

11.2. **Outside Plant Inner Ducts.** Provide a minimum of one conduit with three inner ducts installed within. Install a nylon pull cord within each conduit and each innerduct, as required by UFC 3-580-01.

11.3. **Outside Plant Conduit Bends.** Conduit bends must be limited to the equivalent of no more than two 90-degree bends and must comply with ANSI/TIA-569.

11.4. **Outside Plant Trench Depth.** The minimum trench depth must allow no less than 36 inches of cover from the top of the conduit to the final grade.

11.5. **Outside Plant Trench Usage.** Joint trenches (comm, power, gas, etc.) can be implemented only when the necessary separation distance between services is maintained.

11.6. **Outside Plant Trench Marking.** Orange metallic tracing tape must be laid or installed prior to backfilling all trenches. Install and maintain buried cable markers at no less than 60 feet intervals throughout the project.

11.7. **Manholes and Hand Holes.** Install dedicated manholes and hand holes as required to effectually integrate the facility outside plant pathways with existing base infrastructure.

11.7.1. **Manhole Marking.** Clearly identify all telecommunication manholes and pull boxes with the word "communications" on the cover.

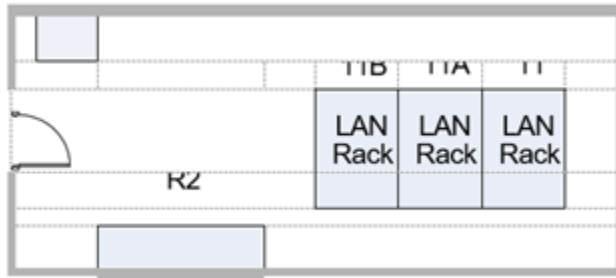
11.7.2. **Manhole Hardware.** Utilize only galvanized hardware for installing and organizing outside plant cabling and splicing components. Manholes and pull boxes must be pre-cast and sized as required to satisfy the maximum conduit and cable required for the facility area.

12. Identification and Labeling. SLD 45 telecommunications labeling must comply with the latest version of ANSI/TIA-606, as required by UFC 3-580-01. All facilities must conform to one labeling scheme and must use only standardized machine generated labels as required by ANSI/TIA-606. The term, "identification", is the systematic numeric, alpha-numeric, or alpha identifier that must be employed for identifying network equipment and cabling and linking the item to the administrative record. The term, "label", refers to a machine-generated text strip that is affixed to telecommunications equipment.

12.1. **Re-Labeling.** SLD 45 facility or TR renovations or upgrades which include 50 percent or greater cable infrastructure replacements or additions must re-label all existing and new cabling and Local Area Network (LAN) drops, as required, to ensure consistent labeling throughout the facility.

12.2. **Rack Identification.** Label the front of telecommunications racks and cabinets, in a sequential manner, from either left to right, or right to left, consistently and without interruption. When TRs require technological or capability updates, the identification system detailed below must be employed for identifying the additional racks.

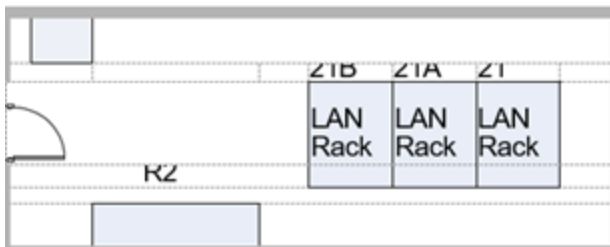
12.2.1. **Rack Labeling First Telecommunications Room.** Identify telecommunications racks and cabinets on each floor of a facility by starting with the rack or cabinet that is nearest to the north side of the building. The first rack, on the first floor, which is nearest to a building's north side, will begin with 11, while subsequent racks in that row must be identified with an additional alphabetical identifier, such as 11A, then 11B, as shown in [Figure 3](#), below.

Figure 3. Rack Identifier Example.

12.2.2. **Rack Labeling Small Telecommunications Rooms.** Small telecommunications spaces include areas with only a few telecommunications racks, cabinets, or may include racks where non-network equipment may be installed. In small telecommunications spaces, label racks sequentially with a numerical and alpha identifier from the door towards the back of the space, as illustrated in [Figure 3.](#), Rack Identifier Example.

12.2.3. **Rack Labeling Additional Telecommunications Rooms.** When a second TR exists, then the room that is next closest to the facilities' north side, and on the same floor, and then the rack which is closest to the north, within that second room, must be identified as rack "12", with the next adjacent rack being identified as rack "12A", then, rack "12B", and so on, until the south side is reached within the room. Additional TRs and racks must follow suit.

12.2.4. **Rack Labeling Multiple Floors.** In multi-floor facilities, each telecommunications space must be labeled with a unique alphanumeric identifier, where the first numeric character corresponds to building floor or level, and the second character identifies the rack or cabinet room, starting at the north side of the building and continuing southward, as shown in [Figure 4.](#)

Figure 4. Multiple Floor Rack Identifier Example.

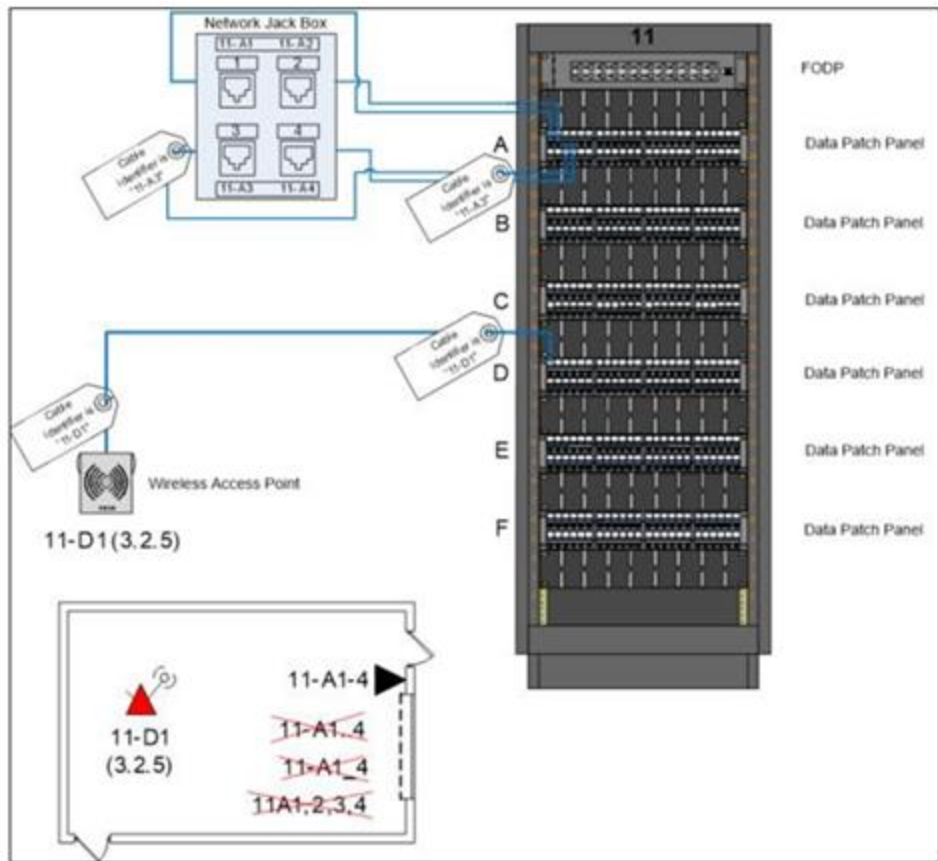
12.3. **Cabling Coloring and Identification.** Telecommunications termination and cross connect cabling must comply with the color coding and machine generated labeling requirements required by ANSI/TIA-606. Reference [Table 2.](#) Telecommunications Cabling Color Coding, which summarizes the color-coding requirements within ANSI/TIA-606.

Table 2. Telecommunications Cabling Color Coding.

Termination Type	Color	General Application
Demarcation Point	Orange	Primary serving area connection
Network Connection	Green	User side of serving area connection
Common Equipment	Purple	PBX, mainframe computer, LAN, and multiplexing connections
Key System	Red	Key telephone connections
1 st Level Backbone	White	Building backbone cable terminations connecting MC to ICs
2 nd Level Backbone	Gray	Building backbone cable terminations connecting ICs to HCs
Campus Backbone	Brown	Backbone cable terminations between buildings
Horizontal	Blue	Horizontal cable terminations in telecommunications spaces
Miscellaneous	Yellow	Alarms, security, and energy management
NOTE: For reference only. Ensure compliance with latest revision of ANSI/TIA-606.		

12.3.1. Horizontal Cabling Identification. Telecommunications horizontal cabling routed from the backside of data patch panels to telecommunications outlets must be systematically labeled with machine-generated text. Each cable identification label must correspond to the physical rack number, followed by a dash, and the patch panel port number (e.g., 11-A3), as shown in [Figure 5](#), below.

Figure 5. Data Only: Rack or Cabinet Patch Panel, Outlet Cable Labeling Example.



NOTE: For reference only.

12.3.2. Inside Premise Optical Fiber Cabling Identification. Inside premise optical fiber cable identification labels must be applied end to end. Each fiber cable must, at a minimum, be labeled with the following identifying details: fiber type, house cable notion, building number and fiber optic distribution panel (FODP) cassette alpha-identifier, and total fiber strand count.

12.3.3. Inside Premise Optical Fiber Identification Example. For instance, a fiber cable label identified as, “FS HC 81900C 1-24”, corresponds to: single mode fiber, house cable, building 81900 and cassette C, and strand count 1-24, respectively.

Table 3. Inside Premise Optical Fiber Ident Example.

Identifier	FS HC 81900C 1-24				
Identifying Detail	FS	HC	81900	C	1-24
Corresponding Information	Single Mode Fiber	House Cable	Building Number	Cassette ID	Strand Count

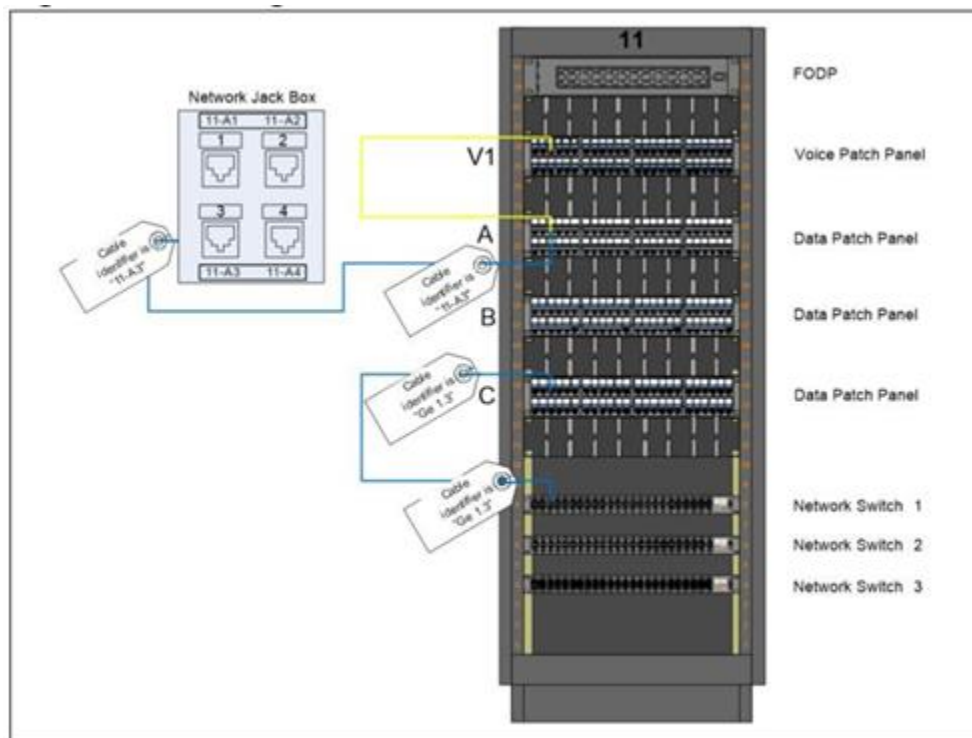
12.3.3.1. Inside Plant Horizontal Optical Fiber Cabling Identification. Inside plant horizontal optical fiber cabling routed from an FODP to a workstation telecommunications outlet must be systematically labeled with machine-generated text that is visible within break-out containment space. Each cable identification label must correspond to the rack where the FODP is installed, followed by a dash, and the patch panel port number. (Rack-FODP-CASSETTE, PORT) example: 11-F1-A01. Currently all FODP panels are identified starting at the top working down ID as F1, F2, F3.

12.3.3.2. Inside Plant Horizontal Optical Fiber Identification Example. For instance, an inside plant horizontal fiber cable label identified as, “11-A01”, corresponds to rack 11, and the end-users’ telecommunications outlet, A01. (Rack-FODP-CASSETTE, PORT) example: 11-F1- A01. Currently all FODP panels are identified starting at the top working down ID as F1, F2, F3.

12.4. **Data Patch Panel Identification.** Telecommunications data patch panels must be labeled alphabetically, on the left side, from the top rack, descending vertically downwards. The top- most patch panel must be labeled beginning with “A”, while the lower descending panels must follow suit, alphabetically, as shown in [Figure 5](#), above.

12.4.1. Converged Data and Network Patch Cord Identification. All patch cords used to interconnect network switches and data patch panels must be systematically identified with labels, from end to end, with machine-generated text. The identifier must correspond to the network rack and physical switch port number, as shown in [Figure 6](#), below.

Figure 6. Converged Data and Voice: Patch Panel, Jack Box, Cable Labeling Example.



NOTE: For reference only. ¶

12.4.2. Voice and Data Patch Cord Identification. Labels are not required for patch cords used to interconnect voice and data patch panels.

12.4.3. Cabling Configurations. Configure all CAT 6 cabling and connectors in accordance with the T568B wiring assignment detailed within the latest revision of ANSI/TIA-568 when required to maintain uniformity in existing installations.

12.4.4. Voice Patch Panels Identification. Voice patch panels must be systematically identified, beginning with “V1”, for the topmost panel label. Lower voice patch panels must follow suit, with “V2”, and so on, as depicted in [Figure 6](#), above.

12.4.5. Patch Panels Port Numbering. Each patch panel port is numerically identified from 1 through 48. To maintain a standardized numbering scheme, when patch panel configurations include subpanels, all ports must still be identified numerically from 1 through 48, as if there were no separation.

12.5. Outlet Identification. Telecommunications outlets, also known as network jack boxes, must be systematically labeled with machine-generated text, in accordance with ANSI/TIA-606.

12.5.1. Outlet Identifiers. Each telecommunications outlet faceplate must be identified with a label that corresponds to its assigned network rack number, patch panel letter, and port identification number. For instance, an outlet identification label, which reads, “11-A1” corresponds to network rack 11, patch panel A, and port 1, respectively. If the drop is a concealed location (e.g., such as behind modular furniture), then an additional label with drop identification on the ceiling grid above the drop must be present.

12.5.2. Outlet Symbol. Telecommunications floor plans must indicate telecommunications outlet locations with a triangle symbol, as required by ANSI/TIA-606.

12.5.3. Outlet Identification Sequence. In both new and renovated facilities, the outlet identification sequence must begin at the main entrance door, starting at the left wall, while facing inward. If there are no hallway outlets, then proceed to the first room, from the left, as facing inward from the main entrance. Identify all outlets in a clockwise manner.

12.5.4. Additional Rooms Identification. For additional rooms where network outlets are installed, proceed inward, from the left, for each room or area. Continue to identify each network box within the second and subsequent rooms, in a clockwise manner, beginning with the leftmost wall and outlet.

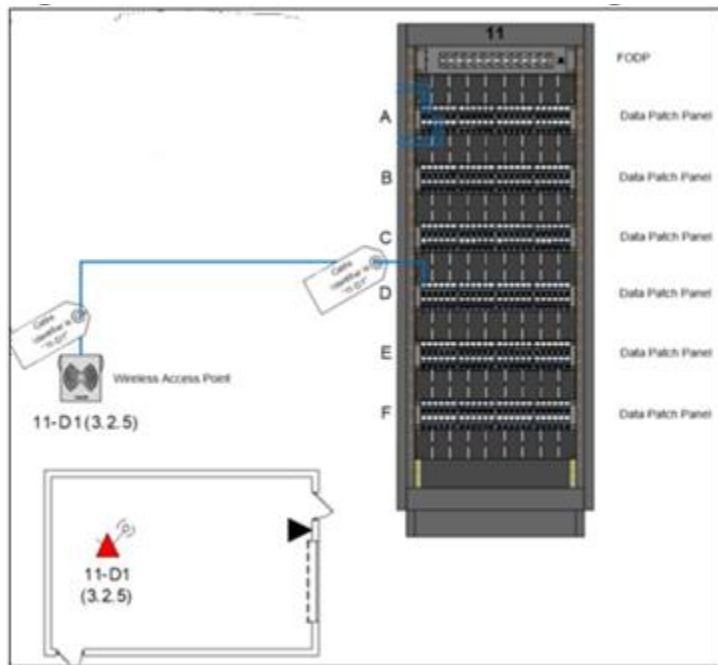
12.5.5. Fiber Optic Distribution. FODPs are installed for both single-mode and multi-mode fiber optic cabling when required at a workstation.

12.5.5.1. FODP Identification. Systematically identify each FODP with machine-generated text labels that correspond to the assigned communications rack number, fiber optic panel number, fiber optic cassette or bulkhead alpha-identifier, and a double digit numeric corresponding to the fiber optic strand. For instance, an FODP identification label, which reads, “11-F1-A01” corresponds to network rack 11, fiber patch panel F1, cassette A, and strand 1, respectively. An FODP with a second optical circuit typically follows sequence, such as “11-F1- A02”.

12.5.5.2. Fiber Optic Strands. The maximum strands accommodated by any cassette must not exceed 24 strands. Installers must route any remaining strands to the next cassette.

12.6. **Wireless Access Points Identification.** Wireless access point devices must be identified by using the same labeling standard used for network outlets, with an additional identifier, in parenthesis, for identifying each individual WAP. An example WAP identification is in [Figure 7](#), below, where the identifier, “11-D1 (3.2.5)” corresponds to: rack 11, data patch panel D1, and WAP 3.2.5, respectively.

Figure 7. Wireless Access Point Labeling Example.



NOTE: For reference only.

12.7. **Grounding and Bonding Identification.** Grounding and bonding identification labeling must comply with ANSI/TIA-606.

12.8. **Outside Fiber Identification.** Label OSP fiber from end to end, and at each termination, with machine generated text labels as shown in [Figure 8.](#), Outside Fiber Cabling Tag Format.

Figure 8. Outside Fiber Cabling Tag Format.

12.9. Floor Plan. A laminated floor plan showing final telecommunications cable distribution, with associated labeling, must be provided by the contractor and mounted in each TR for sustainment purposes.

13. Testing. All telecommunications cabling and hardware must be tested to ensure minimum performance requirements in compliance with ANSI/TIA-568-C, Generic Telecommunications Cabling for Customer Premises. All tests must be performed by a BICSI certified installer using only certified calibrated test equipment. Additional standards compliance is summarized below.

13.1. Unshielded Twisted Pair Cabling and Hardware. Test all UTP CAT 6 cabling and connecting hardware in accordance with ANSI/TIA-568-C. Each individual CAT 6 cable must be tested to confirm the level II performance requirements detailed in TIA/EIA TSB-67 (EIA = Electronic Industries Alliance), Link Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems.

13.1.1. UTP Testing. The minimum required testing includes the following: wire mapping, length measurements, propagation delay measurements, attenuation tests, power sum near-end crosstalk, power sum equal level far-end crosstalk and return loss, equal level far-end crosstalk, and near-end crosstalk loss.

13.1.2. UTP Test Conditions. Testing must be performed with both ends terminated as per TIA/EIA TSB 67, Section 4.

13.1.3. UTP Test Results. When defective pairs are detected, those must be repaired or replaced and then completely re-tested. Re-tests of any UTP cables must include every test to ensure no issues remain, and that no new issues have been inadvertently introduced. No defective cabling or components must remain upon testing completion.

13.2. Fiber Optic Cabling and Hardware. Fiber optic cabling and hardware must be installed as per the installation requirements detailed within UFC 3-580-01. Reference Section 4.8, above, for fiber optic connector types for classified and unclassified systems.

13.2.1. Fiber Optic Testing. Fiber optic cabling and hardware must be tested to verify compliance with the performance requirements required by ANSI/TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard, including visual inspections, length, loss, polarity, attenuation, and return loss measurements.

13.2.2. Fiber Optic Test Conditions. Testing must be performed on completely installed systems, from end to end. Comply with the optical fiber testing requirements using certified calibrated test equipment.

13.2.3. Fiber Optic Test Results. When defective fiber optic cabling or components are detected, those must be repaired or replaced and then completely re-tested. Re-tests of any fiber optic cables must include every test to ensure no issues remain, and that no new issues have been inadvertently introduced. No defective cabling or components must remain upon test completion.

13.3. Test Reports. Complete test reports must be delivered to the SLD 45/SC PM prior to network cutover. The test reports must accurately detail all cabling tests. Reference Section 14, Administration and Documentation, below, for test documentation delivery requirements.

14. Administration and Documentation. The SLD 45/SC PM must coordinate with SLD 45/CES to verify all required project documentation has been included on the project contract data requirements list (CDRL) and is delivered prior to project completion. Telecommunications documentation will be uploaded into the Air Force Cyberspace Infrastructure Planning System (CIPS), as required, for effectually sustaining systems across the project lifecycle. A summary of deliverables required for SLD 45 projects is below.

14.1. **Certifications.** All project telecommunications systems engineering, design, and technical contractors and sub-contractors must provide their applicable BICSI certifications with all pre- construction submittals.

14.1.1. Installer Certifications. Telecommunications technicians employed or contracted to install telecommunications systems for the SLD 45 must be BICSI certified or trained installers. All telecommunications systems renovations, upgrades, or construction projects must be performed by BICSI certified technicians. Provide the applicable BICSI certifications to the SLD 45/SC PM prior to beginning contracted project efforts.

14.2. **Test Documentation.** The SLD 45/SC PM must coordinate with SLD 45/CES to ensure the project specifications require delivery of all telecommunications test reports as detailed above, in Section 13, Testing. All required test reports, including all cable test documents and certifications noted above, in Section 13 Testing, must be included on the project contract data requirements list.

14.2.1. Electronic Test Documentation. All telecommunications equipment and cabling test report documentation, including test equipment calibration certifications, must be delivered to the SLD 45/SC PM. Test reports must include but are not limited to the following details: the actual test result files; date and time of test; facility; telecommunications system detail; cabling details by cable ID number; test equipment type nomenclature, and serial number; technician and company representative. The test results must include the cable ID number for every cable.

14.3. Drawing Requirements. Telecommunications systems drawings are required for all SLD 45 MILCON and renovation projects, as applicable, based on the project scope. All telecommunications systems upgrades or renovations that bring systems and cabling up to standard must comply with the UFC 3-580-01 and ANSI/TIA-606 documentation requirements, as summarized in this section. The telecommunications drawings must represent the as built system and will be recorded in the USAF CIPS for future sustainment efforts.

14.4. As-Built Drawings. The Space Force requires as-built drawings for all voice, data, and video systems installed in new or renovated facilities including military airfield systems, video teleconferencing systems, audio and video distribution systems, radio systems such as land mobile radio, microwave radio, and RADAR systems.

14.4.1. Public Address System Drawings. Drawings are required for permanent PA systems when the PA system is integrated with SLD 45 voice or data systems.

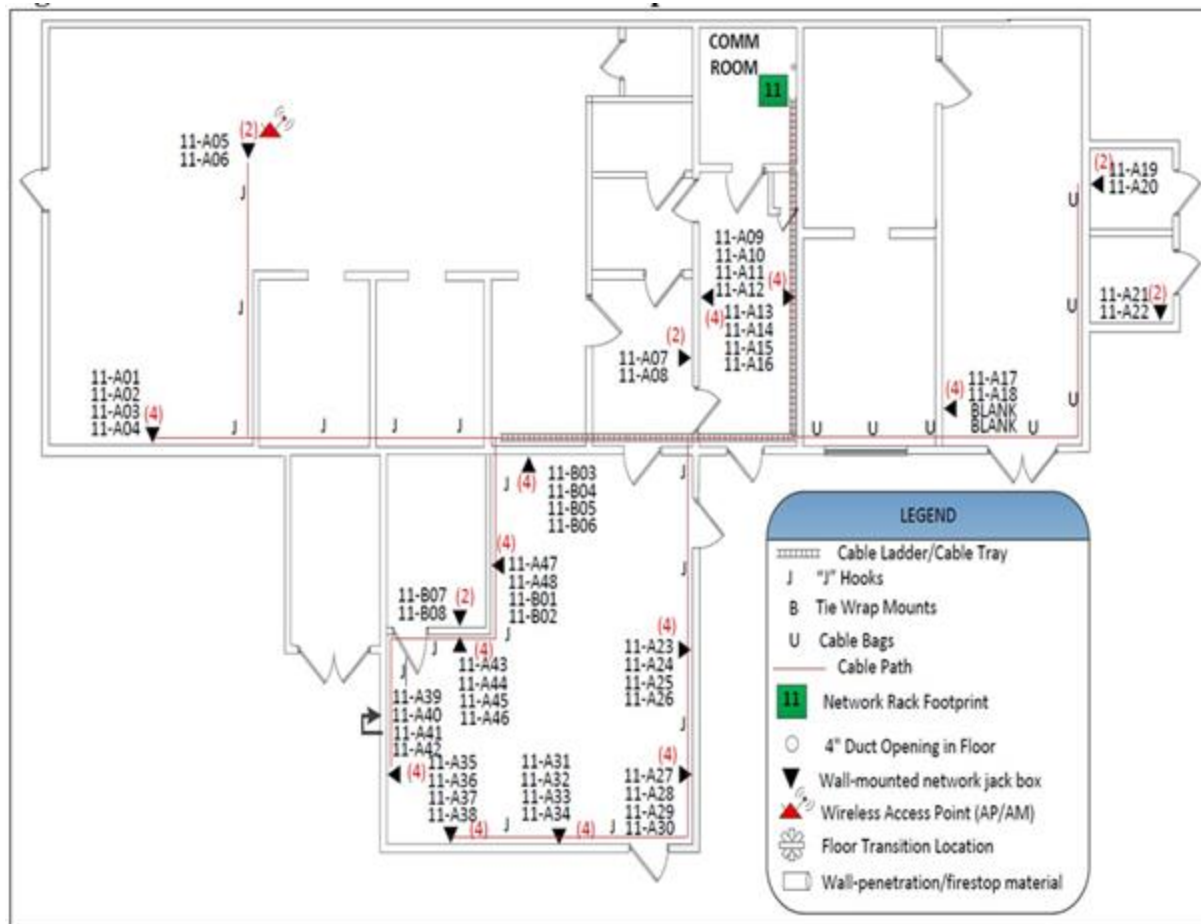
14.4.2. Cable System Drawings. Drawings are required for cable television systems when the cable is integrated with or distributed by means of any SLD 45 network infrastructure.

14.4.3. Security and Alarm Systems Drawings. Drawings are required for security, fire alarm, and environmental monitoring systems when those systems are integrated with SLD 45 networks.

14.4.4. Infrastructure and Cabling Drawings. Drawings are required for detailing telecommunications facilities, spaces, and cabling systems. Facility site and floor plan drawings must include all facets of the facility telecommunications infrastructure and cabling including overhead or underground service entrances, maintenance holes, hand-holes, conduit sizing, conductor sizing and type, including copper pair and fiber quantities. Telecommunications site infrastructure and cabling drawings must include telecommunication entrance facilities' locations and layouts, telecommunications equipment rooms, building distributors, floor distributors, and telecommunications outlet locations.

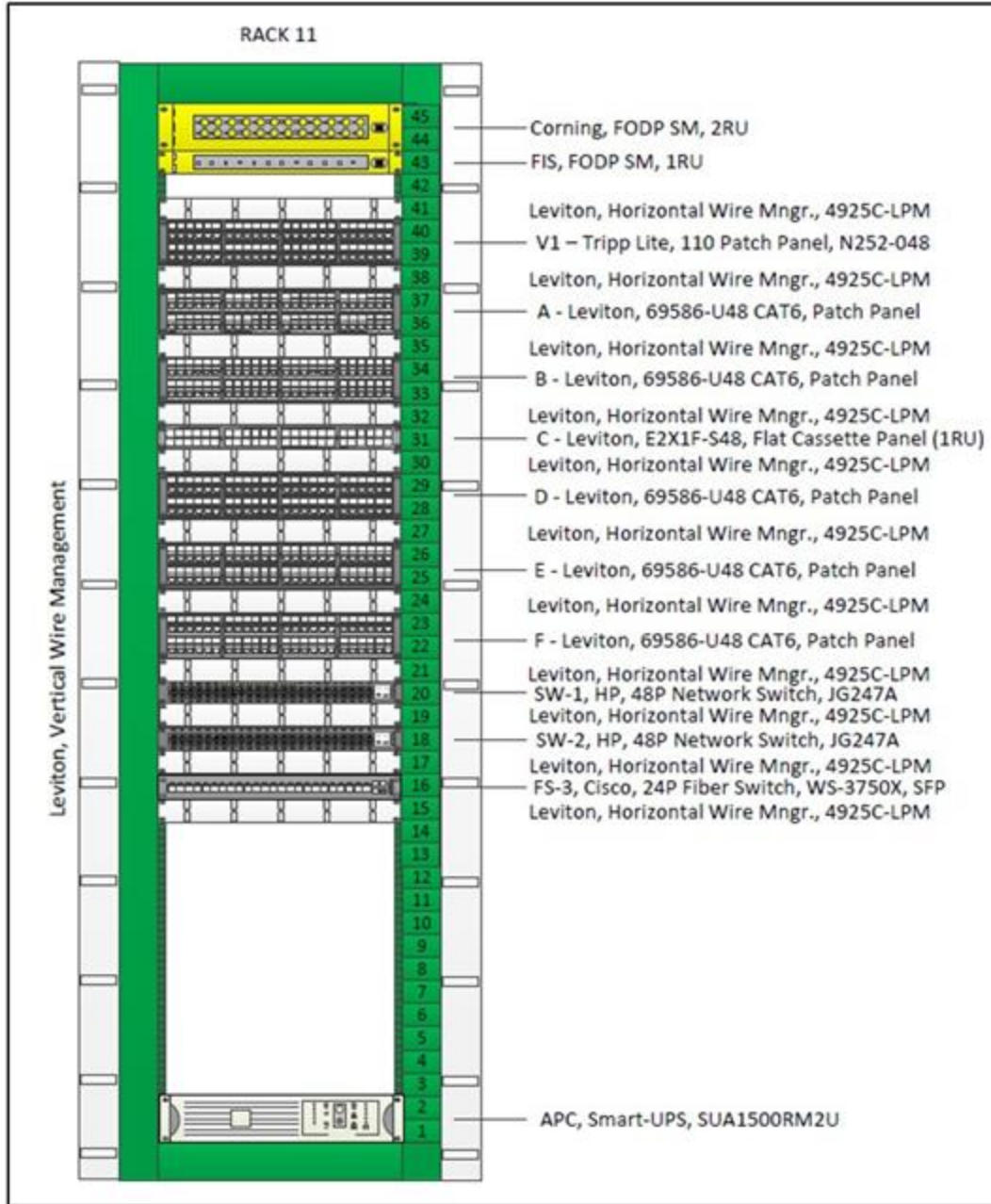
14.4.5. Telecommunications Floor Plans. Telecommunications floor plan drawings are required for detailing the location and placement of equipment racks, wireless devices, telecommunications outlets, and equipment. Telecommunications drawings must also include ducts, cable trays, cable ladders, and other telecommunications infrastructure details. For an example, reference [Figure 9](#), Telecommunications Floor Plan Example.

Figure 9. Telecommunications Floor Plan Example.



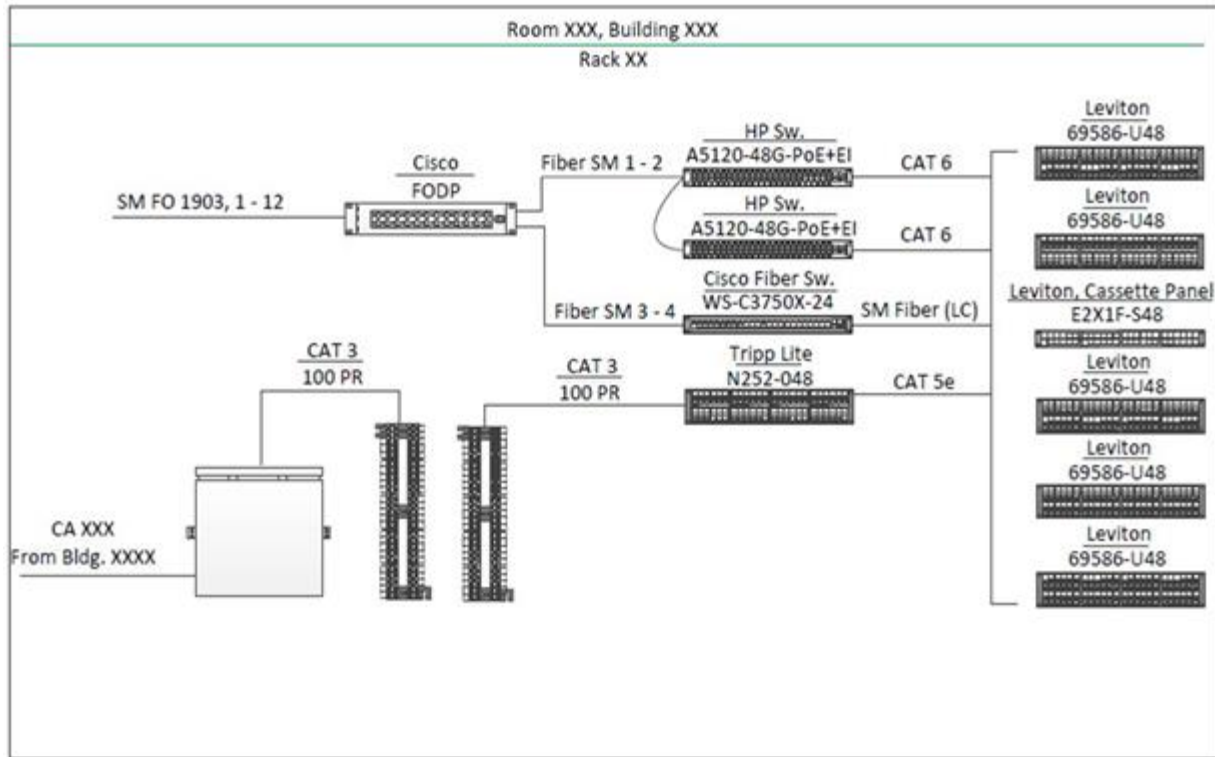
14.4.6. Elevation Drawings. Telecommunication elevation drawings are required and must detail the final two-dimensional representation and location of installed equipment. The level of detail required is that which will provide for the location of racks and cabinets and the equipment installed in each. Each individual rack or cabinet elevation drawing must detail the location and placement of all installed equipment, and provide the corresponding equipment manufacturer, nomenclature, model, and type information, as shown in [Figure 10.](#), Elevation Drawing Example.

Figure 10. Elevation Drawing Example.



14.4.7. Interconnection Drawings. Telecommunication interconnection drawings are required and must detail the end-to-end connections between individual hardware components, as required for complete system functionality. For an example, reference [Figure 11.](#), Network Interconnection Drawing Example.

Figure 11. Network Interconnection Drawing Example.



NOTE: For reference only. Ensure compliance with latest revision of ANSI/TIA-606.

14.5. **Final As-Built Drawings.** All drawings must comply with ANSI/TIA-606 and must include all applicable T Series Drawings, which are summarized below, in [Table 4](#).

Table 4. Telecommunications Drawings Summary.

Drawing Type	Type Title	Summary
T0	Site Plan	Exterior pathways, campus backbone cabling, system nodes, connections, system drawings
T1	Building Layout	Complete building layout per floor and serving zones / areas, including TRs, access points, pathways.
T2	Serving Zone / Area Drawings	Building serving zones / areas with drop locations, access points, TRs, detail call outs for common ERs.
T3	Telecommunications Spaces	TR plan views including racks, cabinets, layouts, and elevations for each rack and cabinet.
T4	Detail Drawings	Labeling, firestopping, ADA, safety, DOT, faceplates, installation procedures, raceways, and rack details.
T5	Schedules	Cut over and cable plant management information.

NOTE: For reference only. Ensure compliance with latest revision of ANSI/TIA-606.

14.5.1. Final As-Built Details. All drawing details must correlate to the installed system identification labels. That is, the physical identification labels placed on racks, cabinets, cables, outlets, and equipment must correspond to the drawing details for each item. Each drawing must include references to applicable standards and instructions.

14.5.2. Final As-Built Format. The final as-built drawings must be delivered in Microsoft Visio® format to the assigned SLD 45/SC PM.

14.6. Drawing Acceptance. The SLD 45/SC Communications Systems Installation Records (CSIR) Manager must verify the delivered drawings are complete, accurate, and in compliance with ANSI/TIA-606 prior to approving and signing the AFTO Form 747.

14.6.1. Air Force Contracts. For USAF contracts, complete and accurate as-built telecommunications drawings must be delivered to the SLD 45/SC PM before AFTO Form 747 is presented for the required block 11 signatures and SLD 45/SC Director acceptance.

14.6.2. Non-Air Force Contracts. For non-USAF contracts, complete and accurate as-built telecommunications drawings must be delivered to the government before facility acceptance.

14.6.3. Facility Construction Contracts. For facility construction contracts, the contract specifications must include the requirement for complete telecommunications drawings as summarized herein and in compliance with ANSI/TIA-606. The contractor must deliver the required as-built drawings at each design review and with the final closeout.

14.7. Site Acceptance. The SLD 45/SC PM must coordinate the final inspection upon completion of the contracted telecommunications project efforts and upon receipt of the 100 percent successful testing reports. The final inspection must serve as the physical verification that the project complies with the project technical and performance requirements. Deliver the test reports to the SLD 45/SC PM prior to the final inspection, as summarized in Section 14.2 Test Documentation.

14.7.1. Site Acceptance PM Authorization. The SLD 45/SC PM will authorize site acceptance by obtaining all required signatures on the project AFTO Form 747. The site acceptance document will clearly document all required testing results and required CDRLs, including the project as-built drawings. Any exceptions to the required results, deliveries, or documentation must be detailed on the site acceptance document.

14.7.2. USSF Site Acceptance. For USSF contracts, the final site acceptance must first be fulfilled, as indicated by a complete AFTO Form 747, prior to issuing funds to the final contractor invoice.

14.8. Contractor Deliverable Requirements List. Delivery of all CDRL items, as required by the contract, must be delivered to the SLD 45/SC PM for all facility construction projects that renovate or modify existing telecommunications infrastructure. The CDRL items must be delivered with the AF Form 3000, Material Approval Submittal. Reference Section 14.0 Administration and Documentation, for telecommunication documentation requirements.

14.8.1. Certifications. BICSI training certifications for each assigned technician must be delivered to the SLD 45/SC PM prior to technician arrival at the worksite. Reference Section 14.1. Certifications, for certification requirements.

14.8.2. Drawings. Before final acceptance, the complete as-built drawings must be delivered to the SLD 45/SC PM, as detailed in Section 14.5 final as-built drawings.

14.8.3. Test Reports. Prior to network cutover, all test reports must be delivered to the SLD 45/SC PM. All test reports, including all cable test reports, must be complete, 100 percent accurate, and without unresolved issues. Reference Section 14.2 Test Documentation.

KRISTIN L. ANZENHAGEN
Brigadier General, USSF
Commander

Attachment 1**GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION*****References***

- AFI 10-404, *Base Support and Expeditionary (BAS&E) Site Planning*, 24 July 2019
- AFI 32-1065, *Grounding Systems*, 14 June 2017
- AFBAN – *Air Force Base Area Network (Functional Specification, A.K.A. BAN-FS)*, February 2021
- AFMAN 33-363, *Management of Records*, 1 March 2008
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- AFPD 17-2, *Cyberspace Operations*, 12 April 2016
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- ANSI/TIA 607-C, *Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises*, 9 November 2015
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- NFPA 70, *National Electrical Code*, 2017
- NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2017
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- Unified Facilities Criteria UFC 3-580-01, *Telecommunications Interior Infrastructure Planning and Design With Change 1*, 1 June 2016
- Unified Facilities Criteria UFC 4-021-02, *Electronic Security Systems (ESS), With Change 1*, 11 September 2019

Unified Facilities Guide Specifications (UFGS) 26 20 00, *Interior Distribution System*, Feb 2014, *Change 3*, September 2021

Unified Facilities Guide Specifications (UFGS) 27 10 00, *Building Telecommunications Cabling System*, August 2011

Unified Facilities Guide Specifications (UFGS) 27 51 16, *Radio and Public Address System*, May 2022

Adopted Forms

AF Form 847, *Recommendation for Change of Publication*

Abbreviations and Acronyms

A—Ampere (A or Amp)

AFI—Air Force Instruction

AFBAN—Air Force Base Area Network (Functional Specification, A.K.A. BAN-FS), February 2021

AFPD—Air Force Policy Directive

AC—Alternating Current

AFMAN—Air Force Manual

AFRIMS—Air Force Records Information Management System

ANSI—American National Standards Institute

AWG—American Wire Gauge

BAS&E—Base Support and Expeditionary

BC—Bonding Conductor

BICSI—Building Industry Consulting Service International

CATV—Cable Television

CAT 6—Category 6

CCTV—Closed-Circuit Television

CDRL—Contractor Data Requirements List, a set of Contractor Deliverable Items

CD-ROM—Compact Disc Read Only Memory

CER—Common Equipment Room

CES—Civil Engineering Squadron

CIPS—Cyberspace Infrastructure Planning System

CSIR—Communications Systems Installation Records

CTR—Common Telecommunications Room

DC—Direct Current

DoD—Department of Defense
DODI—Department of Defense Instruction
EES—Earth Electrode Subsystem
EIA—Electronic Industries Alliance
EMT—Electrical Metallic Tubing
ER—Entrance Room
ESS—Electronic Security Systems
ETL—Engineering Technical Letter
FODP—Fiber Optic Distribution Panel
GE—Grounding Equalizer
HC—Horizontal Cross Connect
HVAC—Heating, Ventilation, & Air Conditioning
IA—Information Assurance
IAW—In Accordance With
IC—Intermediate Cross Connect
ICS—Industrial Control Systems
ID—Identification
IDC—Insulation Displacement Contact/Connector
IS—Information System
ISP—Inside Plant
LAN—Local Area Network
MAJCOM—Major Command
MC—Main Cross Connect
MILCON—Military Construction
NEC—National Electrical Code
NECA—National Electrical Contractors Association
NFPA—National Fire Protection Association
OPR—Office of Primary Responsibility
OSP—Outside Plant
PA—Public Address
PM—Project Manager
PBB—Primary Bonding Busbar

PBX—Private Branch Exchange
RG—Radio Guide
SBB—Secondary Bonding Busbar
SI—Sensitive Information
SC—Communications & Information Flight
SLD—Space Launch Delta
TIA—Telecommunications Industries Association
TBB—Telecommunications Bonding Backbone
TGB—Telecommunications Grounding Busbar
TMGB—Telecommunications Main Grounding Busbar
TR—Telecommunications Room
TS—Telecommunications Space
UFC—Unified Facilities Criteria
UFGS—Unified Facilities Guide Specifications
UL—Underwriters Laboratories
UTP—Unshielded Twisted Pair
VAC—Volts Alternating Current
WAP—Wireless Access Point

Terms

As-built—a drawing record which shows the current state of an object based on its design plus construction changes.

Kcmil—a measure of area in a cross-section of wire, one “mil” equals 1/1000in and one circular mil (*cmil*) equals the area of circle with diameter of 1 mil, where *kcmil* is 1000 circular mils.