BY ORDER OF THE COMMANDER
45TH SPACE WING

45TH SPACE WING INSTRUCTION 33-113

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Communications and Information

COMMUNICATIONS ROOMS INSTALLATION STANDARDS

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This publication implements Air Force Instruction (AFI) 33-150, *Management of Cyberspace Support Activities* and Air Force Policy Directive (AFPD) 33-1, *Information Management.* This instruction sets forth design guidelines for communications rooms and enclosures for the security of the 45th Space Wing (45 SW) data, voice and video network infrastructure. It establishes standards for all new communications pre-construction and renovation design. It also outlines the security procedures for physical access to these locations. By adhering to the standards in this instruction, maintainers can optimize communications equipment lifecycle performance, protect the integrity of the network and manage the premise communications cable distribution system and network demarcation points in government facilities under the jurisdiction of the 45 SW. The intent of this instruction is to set standards for all new construction and facility refurbishments. Existing facilities will be considered on a case-by-case basis. Where applicable, deviations from this instruction for facility refurbishments and/or renovations may be waived with the approval from the base commander. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF Form 847, *Recommendation for Change of Publication*; route AF Form 847s from the field through Major Command (MAJCOM) publications/forms managers. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with (IAW) Air Force Manual (AFMAN) 33-363, *Management of Records*, and disposed of IAW Air Force Records Information Management System (AFRIMS) Records Disposition Schedule (RDS) located at **https://www.my.af.mil/gcss-af61a/afrims/afrims**/.

SUMMARY OF CHANGES

This release is a major re-write and should be reviewed in its entirety. **General Comment.** This document must be used when constructing communications rooms throughout 45 SW facilities. The references section at the end of the document identifies several industry standards that must be adhered to during construction.

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1. Room Specifications and Design.

1.1. Telecommunications Closets/Rooms and Entrance Facility.

1.1.1. Design requirements shall comply with all applicable Electronic Industries Alliance/Telecommunications Industries Association-569 (EIA/TIA-569) sections dealing with telecommunications closet, equipment room, and entrance facilities. The telecommunications closet/equipment room/entrance facility shall be as close to the core of the facility as possible and house only equipment directly related to the telecommunications system and its environmental support systems.

1.1.2. Telecommunication Rooms (TR) shall be sized IAW TIA/EIA-569-B, Unified Facilities Guide Specifications (UFGS) Division 27 10 00, and Unified Facilities Criteria (UFC) 3-580-01 for all new construction projects with a primarily administrative function. Small, mixed-use facilities shall not require full compliance with TIA/EIA-569-B as determined by 45th Space Communications Squadron (SCS) Communications Engineer. Generally, the TR shall be sized to approximately 1.1 percent of the area it serves. For example, a 10,000-square foot (1,000-square meter) area shall be served by a minimum of one 10-foot x 8-foot (3.0 m x 2.4 m) TR. Facilities with requirements

exceeding those of the average administrative building (i.e., C2 facilities, etc.) shall require TRs sized to approximately two percent or more of the area served.

1.1.3. Large floor areas shall be divided into "serving areas" with TRs for each serving area. Each serving area can be no larger than 10,000 square feet (1,000 square meter) as stipulated in TIA/EIA-569-B. The TR sizing allowances shall be made only in cases of construction projects involving building renovation, and under most circumstances a TR shall not be smaller than 10 feet x 8 feet (3 meter x 2.2 meter). The designer shall avoid irregular-sized TRs, such as narrow rooms or odd shapes. TRs shall not contain windows. Adequate space shall be provided in TRs to facilitate tenant-owned telecommunications system support equipment requirements in tenant-installed freestanding cabinets or racks. Total TR space (as a percentage of the building's area) shall be scaled upward to reflect the increased number of circuits in buildings with more than the standard number of circuits to each workspace. Smaller building TRs are covered in TIA/EIA-569-B.

1.1.4. The designer shall consult with the architectural designer or facilities engineer if the TR is to house Voice over Internet Protocol (VoIP), wireless, Power over Ethernet (PoE), or large numbers of network switches. The architectural designer may have to compensate for the additional rack space required to house the VoIP and PoE equipment, Uninterruptible Power Supply (UPS), and servers supporting VoIP and wireless systems.

1.1.5. A minimum of one TR shall be provided per floor. An additional comm room is required if the horizontal cabling distribution distance between the work area outlet and patch panel exceed 90-meters (295-feet). A minimum of three 4-inch conduits shall be provided between floors to each telecommunications room, aligned in a vertically stacked pathway. The equipment room shall be connected to the backbone pathway. Based on the size of the backbone pathway, it may be necessary to install fiber optic cabling between distribution points.

1.1.6. A minimum of two adjacent walls shall be covered with rigidly fixed ¾-inch (20 mm) A-C (e.g. finished front/unfinished back) grade plywood, 8 feet high, capable of supporting attached equipment, mounted 8-inches above the finished floor. Install plywood with the Grade "A" (finished front) surface exposed. Plywood shall be either stamped fire rated or treated on all sides with a minimum of two coats of fire resistant paint. Do not cover the fire stamp on the backboard. Finishes shall be light in color to enhance room lighting. Flooring materials shall have anti-static properties. False ceilings are not permitted within communication closets or entrance facilities. Louvered doors shall not be used when telecommunication closet or entrance facility is located on exterior of building.

1.1.7. Contractor Employee Certifications.

1.1.7.1. Contractor shall provide a minimum of one Building Industry Consulting Service International (BICSI) certified/trained technician(s) for all communications infrastructure modified and/or installed.

1.1.7.1.1. For facility construction contract awards, the 45 SCS Project Manager (PM) and Communications Engineer shall ensure the contract specifications includes a requirement for the contractor to provide the BICSI certification as a

pre-construction submittal.

1.1.7.2. Current training certifications shall be provided to 45 SCS PM before arriving on site.

1.2. **Flood Prevention.**

1.2.1. Communications rooms and enclosures shall be located above any threat of flooding and away from areas of potential water hazard (e.g., restrooms and kitchens).

1.3. **Floor Loading.**

1.3.1. ANSI/TIA/EIA-569-B, Commercial Building Standard for Telecommunication Pathways and Spaces, specifies a minimum floor loading of 2.4 kPa (50 lbf/ft^2). The communications engineer shall determine floor loading for equipment and coordinate with the building architect for actual floor loading rating. If rated floor loading is less than the actual determined requirement, the communications engineer shall obtain the services of a licensed structural engineer.

2. Electrical and Environmental.

2.1. **Power.**

2.1.1. A minimum of two dedicated 20 and/or 30 AMP (as specified), 120 Volt Alternating Current (AC) duplex electrical outlets, each on separate circuits, shall be provided for equipment power. Each electrical outlet shall be placed immediately below, and centered, on each section of attached plywood, and/or rack mounted. A data center will require a separate supply circuit and will be terminated in its own electrical panel. If an emergency power source is available in the building, the equipment room panel shall be linked to the emergency supply. In addition, convenience duplex outlets shall be placed at 6-foot intervals around the perimeter walls, at a minimum height of 8 inches above the finished floor.

2.1.2. Emergency power to communications rooms and enclosures with automatic switchover capability shall be identified as needed (such as server farm areas).

2.1.3. Dedicated power panels shall be installed to serve communications rooms and enclosures as needed.

2.1.4. Distribution panels that serve communications equipment shall be separate from those that serve lighting fixtures.

2.1.5. At least one electrical outlet shall be on normal power and one electrical outlet shall be on emergency power as needed.

2.1.6. Data centers shall require emergency lighting.

2.2. **Grounding and Bonding.**

2.2.1. All classified and unclassified TRs must be connected to the building earth electrode subsystem (EES) IAW J-STD-607-A. Information on grounding of classified facilities can be found in Engineering Technical Letter (ETL) 11-12, *Grounding, Bonding, Testing, and Recordkeeping* for Communications Facilities. An acceptable grounding system encompasses: fault protection grounds, lightning protection grounds, signal reference grounds, and DC power grounds (when applicable). Refer to National

Fire Protection Association (NFPA) 780 and ETL 11-12 for proper lightning protection and NFPA 70 for proper fault protection grounding. The telecommunications designer shall review project drawing to ensure that the lightning and fault protection grounds are addressed by the appropriate disciplines. The telecommunications designer shall ensure that the different grounding systems are not mixed within the building.

2.2.2. The Bonding Conductor for Telecommunications, each telecommunications bonding backbone (TBB) conductor, and each grounding equalizer (GE), shall be green.

2.2.3. J-STD-607-A and UFGS 26-20 uses the following terms for signal grounding: the telecommunications main grounding busbar (TMGB) and the telecommunications-grounding-busbar (TGB) in place of a signal ground bus bar, the TBB in place of the ground conductor, and the GE. NOTE: A TBB is required between the TMGB and all telecommunications grounding busbars (TGBs). A TBB is not required for installation with only a single TGB or TMGB.

2.2.4. Provide a copper conductor TBB IAW TIA-607 with No. 6 AWG minimum size, and sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. Provide a copper conductor bonding conductor for telecommunications between the TMGB and the electrical service ground IAW TIA-607. Size the bonding conductor (BC) for telecommunications the same as the TBB (see Table 1).

Table 1. Sizing of the TBB and BC

Sizing of the TBB and BC	
Length M/Ft	Size (AWG)
Less than 4/13	6
4 - 6/14 – 20	4
6 - 8/21 – 26	3
8 - 10/27 – 33	2
10 - 13/34 – 41	1
13 – 16/42 – 52	1/0
16 – 20/53 – 66	3/0
Greater than 20/66	3/0

2.2.5. Labeling of the grounding and bonding shall comply with TIA/EIA-606.

2.3. **Fire Protection.**

2.3.1. Provide fire protection for communications rooms and enclosures as required by applicable codes.

2.3.2. Where sprinkler heads are provided, install wire cages to prevent potential damage.

2.3.3. Provide drainage for wet pipe systems to protect equipment from any leakage that may occur.

2.3.4. Cover pipes with two coats of fire-retardant red paint as required by applicable codes.

2.4. **Environmental Controls.**

2.4.1. Heating, Ventilation, and Air Conditioning (HVAC) shall be provided on a 24 hours-per-day, 365 days-per-year basis. If the building system cannot ensure continuous operation for equipment applications, a standalone unit shall be provided for the telecommunications equipment room. The temperature and humidity shall be controlled to provide continuous operating ranges of 64ºF to 75ºF with 30 percent to 55 percent relative humidity. Humidification and dehumidification equipment may be required depending upon local environmental conditions. A positive pressure differential with respect to surrounding areas shall be provided. Facilities identified as critical shall also have the TR HVAC system connected to facility UPS or generator.

2.5. **Lighting.**

2.5.1. Lighting shall be a minimum of 540 lx (50-foot candles) measured 3-feet above the finished floor, mounted a minimum of 8.5 feet above finished floor. Lighting fixtures shall not be powered from the same electrical distribution panel as the telecommunications equipment.

3. Cable Plant Specification.

3.1. **Data, Voice and Video Cable Distribution System.**

3.1.1. All cable distribution systems shall be in compliance with ANSI/EIA/TIA 568 series.

3.1.2. Ceiling distribution system shall have adequate pathways or openings through beams and other obstructions into the accessible ceiling space. All structural alterations require the approval of a structural engineer.

3.1.3. Use color-coded cross-connect fields as specified in ANSI/TIA/EIA-606 to facilitate cable plant administration.

3.1.4. Service loop bend radius for vertical and horizontal offsets shall be used as required.

3.1.5. Fire stop all sleeves and slots IAW applicable building codes.

3.1.6. The size and number of conduits or sleeves used for backbone pathways shall be proportional to the floor space served by the cable distribution system to include multiple interconnected communication rooms and enclosures.

3.1.7. The 45 SCS Commander or appointed representative(s) shall be the approval authority for all horizontal pathways, conduits, trays and duct designs to include wired and wireless access points for communication distribution systems.

3.2. **Conduits, Trays, Slots, Sleeves, and Duct Requirements/Specification.**

3.2.1. Cable Trays/Ladders

3.2.1.1. Solid bottom, slotted bottom, or welded wire cable tray shall be used to provide a centralized cable management/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 shall be designed to accommodate a maximum calculated fill ratio of 50 percent to a maximum inside depth of 6 in (150 mm). Ladder cable tray

should be avoided for horizontal distribution. Provide 12 inches of clearance above cable trays for future access. Designers shall coordinate with other disciplines to ensure clearances can be achieved. Cable ladders shall not be used in lieu of cable trays. All metallic cable trays shall be bonded to the ground busbar. Individual sections of the cable tray run shall be bonded together.

3.2.2. Enclosed Duct (Raceway).

3.2.2.1. When a building design does not provide for installation of cable tray, enclosed square duct may be installed. Enclosed duct may also be used in place of cable tray when cable plant requires physical security. For initial design guidance, provide 650 sq mm (1 sq inch) of cross-sectional area of the enclosed duct per outlet location. During actual design, the designer must plan for an optimal fill ratio of 40 percent. A fill ratio of 50 percent shall never be exceeded. Provide 12 inches (300 mm) of clearance above cable trays for future access, as per TIA/EIA-569-B paragraph 4.5.6.2.

3.2.3. Conduit.

3.2.3.1. Electrical metallic tubing (EMT) conduit shall be installed from the cable backbone distribution system, whether cable tray or enclosed duct, to each outlet or installed from a receptacle box into an accessible ceiling space directly above the receptacle box (stub-up). Conduit for standard outlets shall be a minimum of 1-inch (27 mm) EMT conduit. Conduit runs shall be placed at every point where an electrical outlet is installed in the facility for communications outlets.

3.2.3.2. All installed EMT conduit runs shall be limited to the equivalent of no more than two 90-degree bends. The inside radius of a bend in conduit shall be at least 6 times the internal diameter. When the conduit size is 2-inches or greater, the inside radius of a bend shall be at least 10 times the internal diameter of the conduit. For fiber optic cabling, the inside radius of a bend shall always be at least 10 times the internal diameter of the conduit.

3.2.3.3. An optimal conduit fill ratio of 40 percent should be accommodated for conduit. Under no circumstances shall the designer exceed a fill capacity ratio of 50 percent. No more than four, four-pair cables may be in a 1 inch (27 mm) conduit. Conduits shall be bonded to either the TMGB, TGB, where present, or to the cable tray. Stub-up/stub-out conduits are generally not grounded.

3.2.4. Pull Boxes.

3.2.4.1. Pull boxes shall 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 shall be placed in straight runs of conduit and not be used in lieu of a bend.

3.2.5. Non-continuous Cable Supports.

3.2.5.1. Provide suitable supports that provide a continuous accessible pathway for cables not supported by conduit or cable tray. Non-continuous cable supports shall not be used in lieu of the cable tray system. Non-continuous cable supports (J-hooks, saddlebags, etc.) shall be specifically designed to support category-rated cabling.

Supports shall not exceed 20 cables or 50 percent of the fill capacity, whichever is less. Spacing between supports shall not exceed five feet.

3.2.5.2. The installation of pathways, pathway supports and components shall comply with BICSI installation practices and methodologies as defined in the Information Transport Systems Installation Manual, UFC-3-580-01, UFGS Division 27 standards, and the NECA/BICSI 568 installation standard.

3.2.6. Cabling and Termination.

3.2.6.1. New construction horizontal cabling shall be four-pair, 100-ohm, unshielded twisted-pair (UTP), Category-6 rated, specified to handle transmission speeds of 250 MHz (minimum). The use of Teflon insulated, plenum rated Category-6 cable is acceptable for both plenum and non-plenum applications. When Teflon insulated plenum rated cable is used, it shall be Type 4X0 (type 3X1 and 2X2 are not acceptable). All cable shall be level verified and cable jackets shall be factory marked at regular intervals identifying type and performance level. All facility renovations shall install a minimum of CAT 6 cabling or higher.

3.2.6.2. All connecting hardware shall meet Category-6 performance rating requirements and be marked accordingly by the manufacturer. Wall outlet assemblies shall be Category-6 rated and shall have a minimum of four RJ-45 type plugs. All eight conductors per cable shall be terminated on the same jack with no bridged taps, splices or split pairs. Modular outlet jack inserts shall be 8-pin, 8-position, RJ-45 type, color-coded, 110-type, Insulation Displacement Connection (IDC) connectors. The faceplate shall also have a built-in cover for label inserts.

3.2.6.3. Category-6 rated, 19-inch or 23-inch (as required by 45 SCS Communications Engineer) data patch panel shall be installed with attached front and back wire management devices. Category-5e rated, 19-inch or 23-inch (as required by 45 SCS Communications Engineer) voice patch panel shall be installed with attached front and back wire management devices. The front panel shall consist of 8-pin, 8-position, RJ-45 connections. The rear panel shall consist of color-coded, 110-type IDC. Patch panels shall be mounted in equipment cabinets or comm racks with sufficient ports to accommodate the installed cable plant plus 25 percent spares.

3.2.6.4. All common communication components shall be Category-6 rated and wired to the T568B configuration.

3.2.6.5. Backbone cable type shall consist of 50/125-micron single-mode fiber optic cable, 150-ohm shielded twisted pair or 25 pair power-sum Category-6. In any case, the type of cable or connectors to be installed will be approved by 45 SCS PM. Fiber terminations shall use the LC or SC type connectors to unclassified patch panel and SC connectors for the classified patch panels.

3.2.6.6. Unless otherwise stated, exterior copper cable shall be gel filled, polyethylene insulated conductor cable (PIC), sized to fit the square footage of the facility.

3.2.6.7. Coaxial cable systems shall be RG-11 cable for Outside Plant (OSP) use and RG-6 for inside use. The cable shall utilize “F” and RJ-45 type plug/connectors,

balance to unbalance (BALUN) adapter, line splitters, couplers, fittings, and wall mounting faceplates as needed.

3.3. **Wall and Rack Space for Terminations.**

3.3.1. Location and space allocation for terminations of each type of cable should be on one continuous wall or rack.

3.3.2. A clear space of 5 to 6 inches above and below the top and bottom of the connecting hardware or cable handling will be reserved.

3.3.3. Special size considerations and termination space for various cable types shall be located in the design specification.

3.3.4. Mounting connecting hardware and equipment close to corners should not be used to avoid servicing problems. Layout side clearance should be located in design specification.

3.3.5. Narrow side walls must be reserved for "splice cases" and miscellaneous items.

3.3.6. Cross-connect fields patch panels and active equipment in communications rooms and enclosures must be placed to allow cross-connections and interconnections. Connections can be made via jumpers, patch cords and equipment cables whose lengths per channel do not exceed 16 feet for patch cords or jumpers in the horizontal cross-connect (floor distribution). Space must also allow for patch cords/jumpers that do not exceed 33 feet, equipment cables connected to the horizontal cross-connect (floor distribution), plus the work area cord and 66 feet for patch cords or jumpers that serve main or intermediate cross-connects (building distributions).

3.4. **Labeling.**

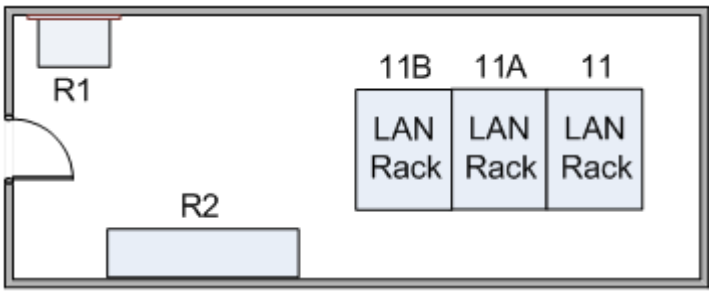
3.4.1. The telecommunications systems labeling shall be done IAW TIA/EIA 606-A-1 per UFC-3-580-01 accepted by the Air Force in June 2007. It is desirable that all facilities conform to one unique labeling scheme described below. All designations shall be done in standard commercial labeling, and no handwritten labels are to be used.

3.4.2. Rack Identifiers.

3.4.2.1. The network rack/cabinet closet to the North-side of the building, and on the first floor of a building, is named rack "11". If this building has a second communications room, though further from the North-side, and on the same floor, it is named rack "12", and so on, in parallel until the buildings South-side is reached. If there is a second network rack or cabinet within a communications room, the first rack (11) remains "11" and the second rack accepts a third character as "A" (making the second rack "11A"). The third network rack is identified as "11B", etc. This naming convention is read from the front of the racks, and from either left-to-right or right-to-left, in ascending or descending order, so that this sequence remains uninterrupted. If the technology changes inside the communications room, the conventional sequential numbering system is employed for those particular racks or cabinets. Figure 1 illustrates the typical naming of racks in very small telecommunications rooms, when the cabinets and racks are of various sizes and placement. In a small space that contains just a few racks, wall cabinets and floor

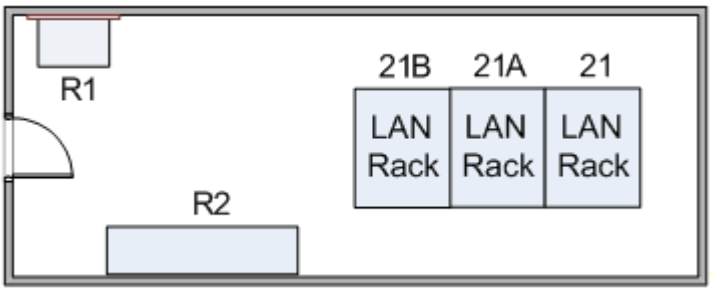
mounted racks containing other-than network technology are named by a sequential rack number as counted from the door to the back of the room.

Figure 1. Rack Identifier Example



3.4.2.2. For multiple floor buildings, each telecommunications space has a unique identifier where the first numeric character identifies the floor of the building, and the second character identifies the rack or cabinet closets to the North-side of the building, as shown in Figure 2.

Figure 2. Rack Identifier Example



3.4.3. Patch Panel Labeling.

3.4.3.1. All network rack patch panels will be labeled vertically on the left side. The first digital patch panel appearing highest in the rack will be labeled alphabetically starting with capital letter “A”, followed by the second panel labeled as “B”, as illustrated in Figure 3. Voice patch panels will be labeled “V1”, and the next as “V2”, in ascending order from the top down, as shown in Figure 4. Patch panel ports are identified by number in sequential order (e.g. 1 through 48). For patch panels that include subpanels, the separation between subpanels is ignored, and the ascending sequential numbering remains uninterrupted.

3.4.4. Network Jack Box Labeling.

3.4.4.1. Network jack boxes shall be labeled IAW TIA/EIA-606-A-1, or newer version. For new or renovated facilities the first jack box shall be installed and labeled starting from the northwest facility room and northwest wall. Additional network boxes within this room shall be installed in a clockwise manner. The next room requiring installation of jack boxes/labeling will be determined by a general progression from west to east, while also generally progressing from north to south, within the facility. The jack box wall outlet plate shall be labeled per the assigned network rack number, patch panel letter and port identification (ID) number (e.g. 11-

A1). Each jack box shall be symbolized by a triangle on the floor plan and labeled as illustrated in Figure 3. Wireless receivers shall be illustrated on a floor plan using the standard wireless symbol shown in red. These receivers will utilize the same labeling method as the network jack box. However, each wireless access point (WAP) receiver requires an additional identifier which is documented in parenthesis, as it appears on the device. This is illustrated per Figure 3, displayed as “11-D1 (3.2.5)”.

3.4.5. Cable Labels.

3.4.5.1. All network horizontal cabling routed from the backside of the patch panel to the wall jack box shall be identified/labeled by the rack number, followed by a dash, and the patch panel port number as shown in figure 3 (e.g. 11-A3).

3.4.5.2. Patch cord labeling is not required for interconnections between voice and data patch panels. However, labeling is required on all patch cords connected between the network switch and the data patch panels. This patch cord shall be labeled end-to-end to include the network rack identifier and associated switch port number as shown if Figure 4.

3.4.5.3. Fiber cabling shall be labeled end to end as illustrated per Figure 6, Cable Tag Format, and addressed in paragraph 3.7.2.3.

Figure 3. Example of Patch Panel, Jack Box, and Cable Labeling when a rack is used for data only

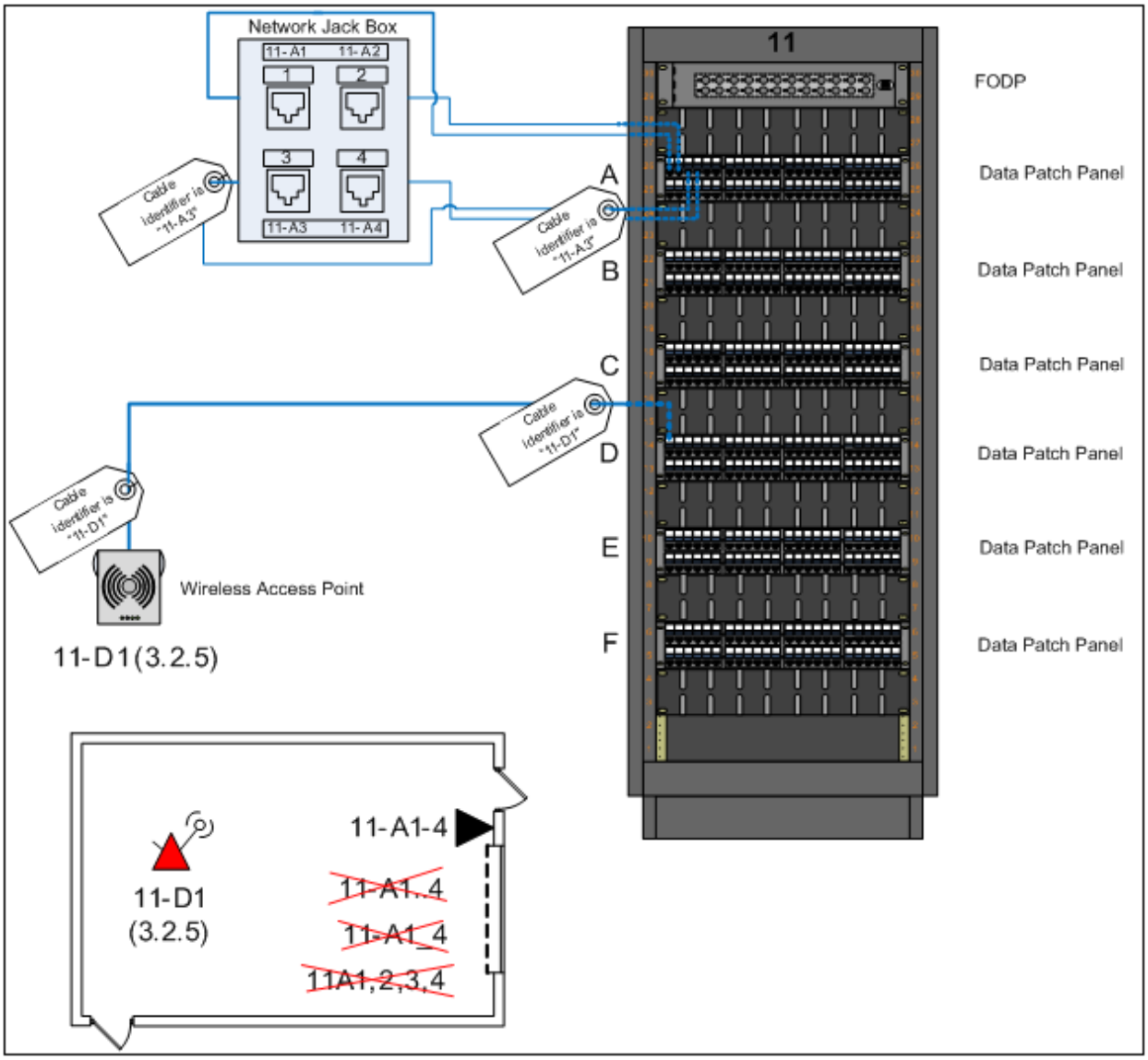
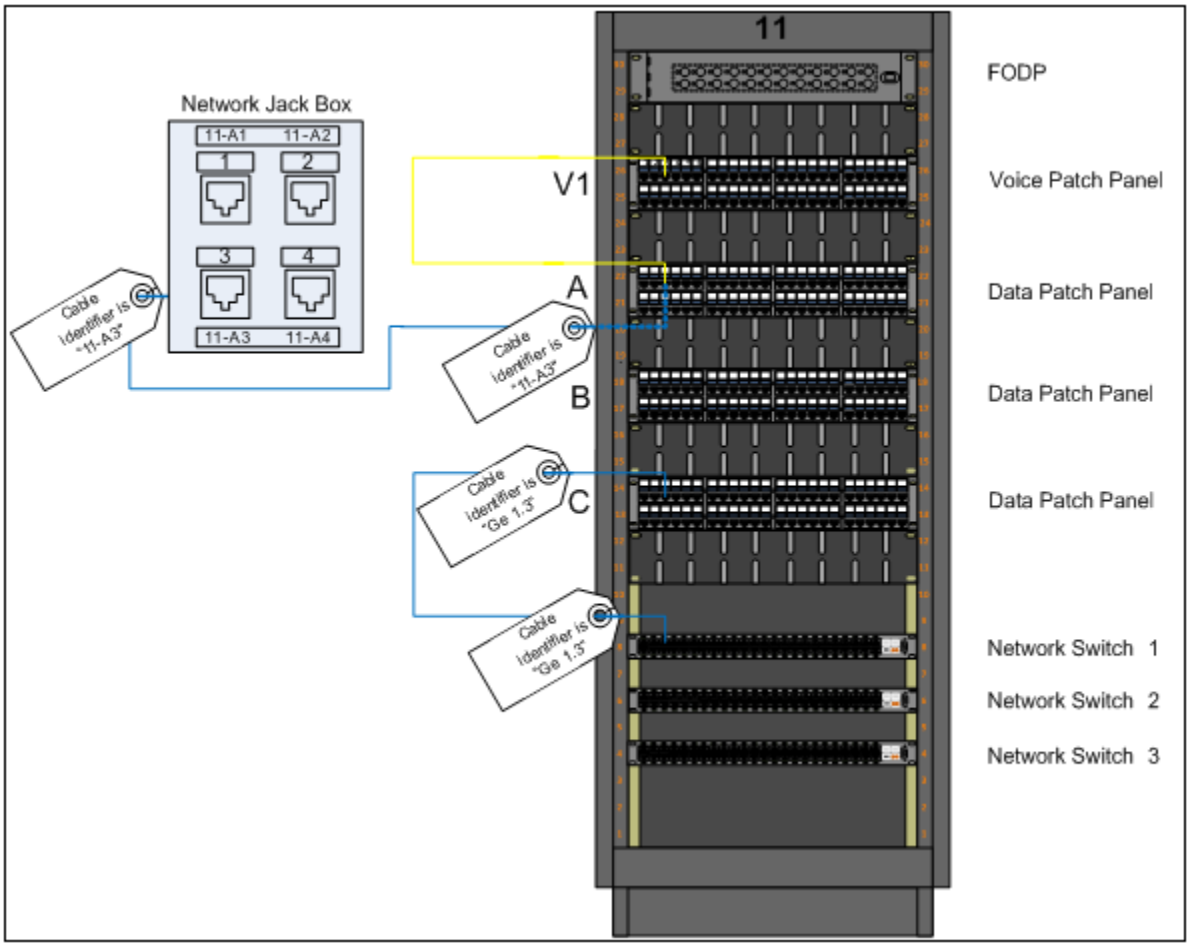


Figure 4. Example of Patch Panel, Jack Box, and Cable Labeling when Voice and Data are converged within the same rack



3.5. **Building Backbone Cable.**

3.5.1. Facility backbone cable shall be installed to connect entrance facilities, equipment rooms, and telecommunication closets. Reference: UFC-3-580-01, para 2-4.2.

3.5.2. Backbone systems shall use a physical star wiring topology and have no more than two (2) levels of cross-connects to reach the highest level (i.e. main cross-connect, intermediate cross-connects, and horizontal cross-connects are acceptable).

3.5.3. Appropriately sized conduit and/or raceway system shall be used to protect backbone cables.

3.6. **Horizontal Cable System.**

3.6.1. Sizing of network wall outlets shall be based on the square footage of the room/area and the type/quantity of comm equipment requiring network connectivity. Therefore, if the room/area is limited to telephone and/or wireless access point equipment only, a single or dual outlet is required. For a small office area (e.g. 8’x10’) limited to one occupant who has a computer, telephone and printer, two quad outlets (filled with two cables) shall be installed. The number of network outlets required for larger office

areas containing multiple personnel and/or network equipment shall be determined on a case by case basis. Cabling systems shall allow for one telecommunications outlet (quad drop) at every point where an electrical outlet is placed. All telecommunication outlets shall be located on the opposite side of the same stud as the electrical outlet. If electrical outlets do not exist, a minimum of one telecommunication outlet (quad drop) shall be installed for every ten (10) linear feet of office space/planned cubical space. A telecommunication outlet (□) is defined as four Category-6 cables. Cabling supporting phones in hallways, TRs and mechanical rooms will only require two Category-6 cables.

3.6.2. Wiring.

3.6.2.1. All copper and fiber optic cable runs shall be in compliance with TIA/EIA-568-A and EIA/TIA-569. All cabling runs shall have one side terminated to the wall outlet and one side terminated to the appropriate patch panel in a star topology. Horizontal wiring shall be supported from end-to-end with the proper use of D-rings, J-hooks, saddlebags, cable trays, and/or ladder racks (depending on the quantity of cable to be installed). Ensure a slack (10 feet) is provided at the rack/patch panel termination point to provide for future service, repair, and relocation.

3.6.2.2. All single copper cables, not enclosed in metallic conduit or ducts, shall maintain at least 8 inches separation from parallel runs of conduit containing power cables. All copper cable bundles, not enclosed in metallic conduit or ducts, shall maintain at least 12 inches separation from parallel runs of conduit containing power cables.

3.6.2.3. The installed cabling system shall be color-coded, machine printed labeled, and documentation in compliance with TIA/EIA-606.

3.6.2.4. All Category-6 cabling and associated connectors shall be configured to the T568B wiring configuration standard listed within TIA/EIA-568-A.

3.6.2.5. The connecting hardware used for UTP cabling shall be installed to provide minimal signal impairment by preserving wire pair twists as close as possible to the point of mechanical termination. The amount of untwisting in a pair, as a result of termination to connecting hardware, shall be no greater than ½-inch for Category-6 cables.

3.6.2.6. A laminated floor plan showing the facilities final cable distribution runs, with associated labeling, shall be mounted in each telecommunication room.

3.7. **Exterior Conduit, Cable and Manhole System.**

3.7.1. Exterior Conduit System.

3.7.1.1. An underground service entrance pathway shall be provided to support the base distribution system. The minimum size of this pathway shall consist of 4-inch conduits. A minimum of three conduits shall be provided from the entrance facility to the nearest service connection point. Exact number and size of conduits will depend on total footage of the facility and shall be in compliance with EIA/TIA-569. At least one conduit shall have three inner ducts installed, each with nylon pull cords. The other conduit(s) shall also contain a nylon pull cord. Bends in conduit shall be limited to the equivalent of no more than two 90-degree bends.

3.7.1.2. The minimum depth of a trench shall allow 36-inches of cover from the top of the conduit to the final grade. Joint-trenches (comm, power, gas, etc.) can be used provided appropriate separation is maintained. Orange metallic tracing tape must be laid/installed prior to back filling the trench. Buried cable markers shall be installed a minimum of every 60 feet.

3.7.2. Fiber and Copper Cable.

3.7.2.1. A minimum 12-strand, single-mode, loose buffer tube-type fiber optic cable shall be provided and installed from the facility entrance point to the nearest fiber service connection point. More fiber strands can be installed depending on the user's requirement (e.g., datacenter, Information Transfer Node, End Building Node). A small amount of slack (15-feet to 20-feet) at each end of the cable shall be provided for future service, repair, and relocation. All fiber strands shall be terminated at the equipment rack patch panels using LC or SC type connectors for unclassified and classified network. Corrugated or fabric inner duct shall be installed/utilized to protect and identify the Optical Fiber Cable and will be rated for the same environment as the cable. Use of existing ST type connectors is allowed if the rack or FODP is being relocated/repaired.

3.7.2.2. Exterior copper cable shall be gel filled, PIC, sized to fit the square footage of the facility. Cable shall be provided and installed from the facility entrance point to the nearest copper service connection point. A small amount of slack (15-feet to 20-feet) at each end of the cable shall be provided for future service, repair, and relocation. All copper pairs shall be spliced using surge protection modules (when applicable) and 66 punch down blocks bolted to the entrance facility A-C plywood backboard (Figure 5). Existing 66 blocks will be utilized (e.g. grandfathered) if the OSP is not modified or relocated.

3.7.2.3. Required fiber optic cable tag format is illustrated in figure 6.

Figure 5. Fiber/Copper Termination

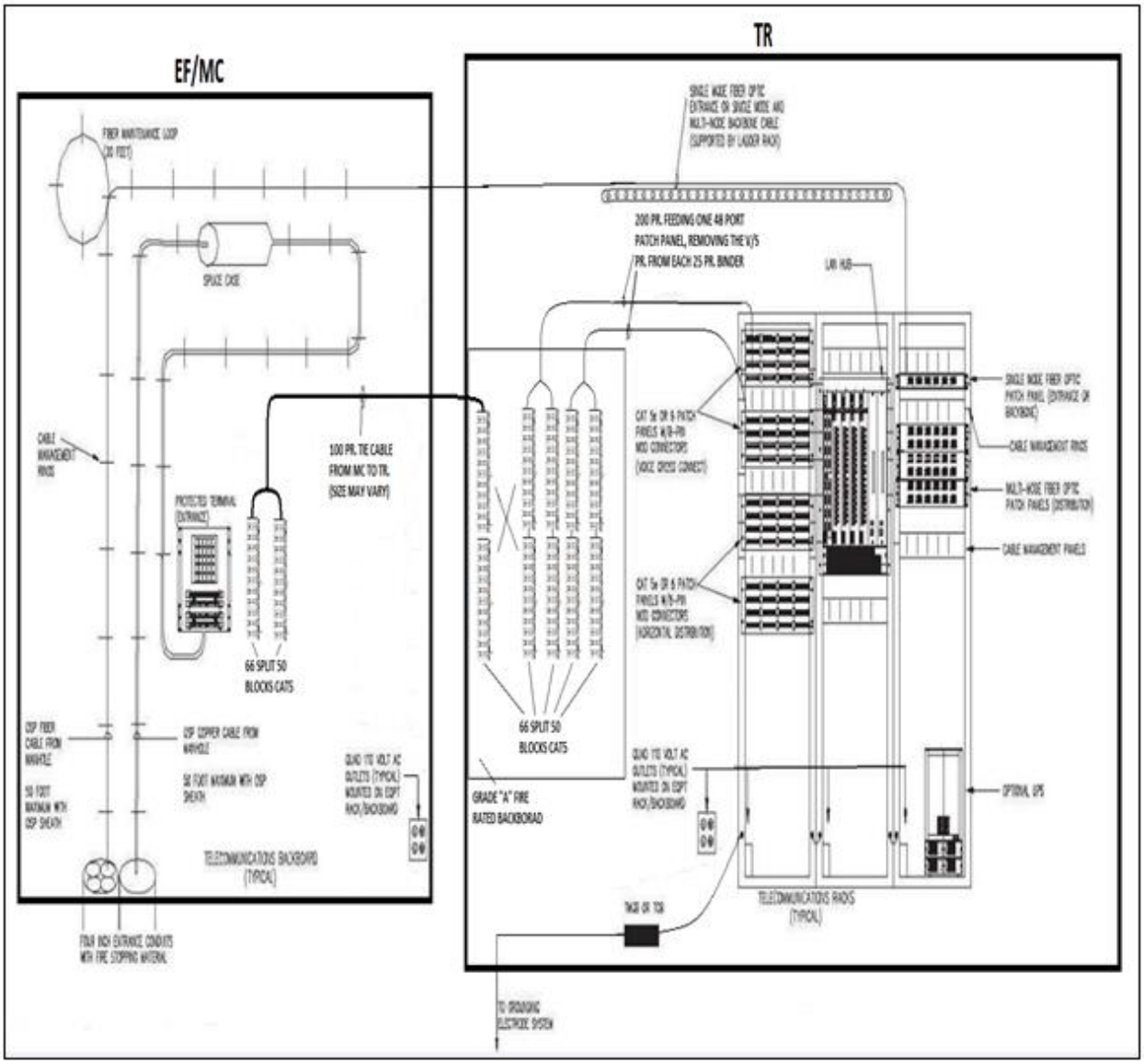


Figure 6. Cable Tag Format

For Single Cable

1 2 3 4 5 6

A12L8.3F

For Hybrid Cable

1 2 3 4 5 6

A12L10/30L62.5F

1. A = ARMORED SHEATH
   B = BLOWN FIBER
   F = INDOOR/OUTDOOR FIBER
   OTHERWISE LEAVE BLANK
2. FIBER COUNT
3. L = LOOSE TUBE BUFFER
   T = TIGHT TUBE BUFFER
4. 8.3, 9.2 OR 10 = SINGLE MODE *
   50 OR 62.5 = MULTIMODE **
5. F = FILLED CORE OR LEAVE BLANK
   D = DRY CABLE

* When Single Mode Fiber is unknown replace numeric value with 'S'
** When Multi Mode Fiber is unknown replace numeric value with 'M'

OPTION 1
FO 1234 -5678,1-12
FO= FIBER OPTIC CABLE
1234 - 5678 = FROM - TO BUILDING NUMBERS

OPTION 2
FO 02,1-12
FO=FIBER OPTIC CABLE
02=LOCALLY ASSIGNED CABLE NUMBER
1-12=CABLE COUNT

3.7.3. Manholes.

3.7.3.1. Dedicated telecommunication manhole(s) and/or hand hole(s) shall be installed to optimize the use of existing base infrastructure.

3.7.3.2. All telecommunication manholes and pull boxes shall be clearly marked with the word "Communications" on the cover. The interior shall include all galvanized hardware needed for organized placement of cable and splicing components.

3.7.3.3. Manholes/pull boxes shall be pre-cast and sized to meet maximum conduit/cable requirements for the size of the facility.

3.8. **Cable Television (CATV) Distribution Systems.**

3.8.1. This cable system shall consist of RG-6 cabling and shall be capable of transmitting UHF and VHF television signals from the base commercial cable television carrier and/or any satellite television carrier. The cable system shall also include connectors, line splitters, couplers, fittings, wall-mounted faceplates, and other support equipment as needed.

3.8.2. Cable systems shall be wired from the entrance facility to rooms selected by the 45 CES, the building occupants, and 45 SCS PM. Each cable run shall be marked at both ends to identify the room number/outlet location.

3.9. **Additional Communications Equipment.**

3.9.1. Public Address System shall be designed and installed IAW UFGS 27 51 16 Radio and Public Address System.

3.9.2. Supervisory Control and Data Acquisition (SCADA) Systems shall be referred to the 45 CES. The system shall follow the network installation practices when connected to the base network infrastructure.

3.10. **As-built Drawings.**

3.10.1. As-built drawings are required for all voice, data, and video systems housed in new or newly renovated facilities. The Air Force requires as-built drawings for all military air field systems, video teleconferencing systems, audio and video distribution systems, all radio systems such as Land Mobile Radio (LMR), Microwave Radio, and Radars. Permanent Public Address Systems require as-built drawings when they interface with the base telephone system. Cable television requires as-built drawings when distributed over the base network. As-built drawings are not required for security, fire alarm, and environmental monitoring systems if they don't interface with the base network. As-built drawings shall be delivered in Microsoft Visio format. 45 SCS PM will issue a government furnished laptop with associated software applications to the 45 CES PM for contractor use. The laptop will be returned to the 45 SCS PM with completed drawings to be reviewed for accuracy prior to 45 SCX Communications Systems Installation Records (CSIR) Manager signing the AFTO Form 747.

3.10.2. As-built drawings shall locate the placement of equipment racks, wireless devices and Local Area Network (LAN) outlets, ducts, cable trays and cable ladders, on established floor plans. Elevation drawings shall show the final two-dimensional appearance of the communication equipment installed, and these demographics shall be greater than a rectangle but considerably lower than a digital photo, and be identified by rack units, by name, by manufacturer, and by model. A basic line-diagram (cables) shall show end-to-end connectivity between pieces of hardware or equipment items, thereby demonstrating the system will function properly. The as-built drawings shall depict the design and building of a telecommunications cabling system. Site plans and floor plans shall show overhead or underground service entrances, maintenance holes, hand-holes, conduit sizes, conductor sizes and type, number of pairs and fibers, and physical locations and layout of telecommunication entrance facilities, telecommunications equipment rooms, building distributers, floor distributers, and telecommunications outlets. The final communication as-built drawings must be accurate and delivered to the 45 SCS PM

before the AFTO Form 747 is presented for required signatures listed in blocks 11, recommending 45 SCS Commander accept contractor services provided. All as-built drawings shall be provided to 45 SCS PM prior to submission of AFTO Form 747 for signatures.

3.10.2.1. For facility construction contract awards, the 45 SCS PM and Communications Engineer shall ensure the contract specifications includes a requirement for the contractor to provide all as-built drawings in Visio format as a construction closeout submittal.

3.11. **Testing and Documentation**

3.11.1. All cable runs shall be tested to the accuracy level II requirements described in TIA/EIA TSB 67. In addition, an experienced installer, as defined in paragraph 1.03.A, shall perform all testing. At a minimum, testing shall consist of wire map verification, length measurement, propagation delay measurement, attenuation, Power sum near-end crosstalk (PSNEXT), Power sum ELFEXT (PSELFEXT) and return loss, Equal level far-end crosstalk (ELFEXT), and near-end cross-talk (NEXT) loss. There shall not be any defective pairs in the final installation of the telecommunications cabling. Testing shall be performed with both ends terminated, per section 4 of TIA/EIA TSB 67. All cable test reports shall be provided to 45 SCS PM prior to submission of AFTO Form 747 for signatures.

3.11.1.1. For facility construction contract awards, the 45 SCS PM and Communications Engineer shall ensure the contract specifications includes a requirement for the contractor to provide all cable test reports as a close out submittal.

3.11.2. All contractor installed cabling shall be 100 percent tested after termination per paragraph 2-10 and additional sub-paragraphs listed in UFC 3-580-1. All UTP and fiber optic cabling shall be tested end-to-end and certified to meet performance TIA/EIA standards. All equipment shall be tested to meet contract specifications. All test results and certifications shall be provided to the 45 SCS PM.

3.11.2.1. Electronic documents shall be provided for all cable tests per the test equipment utilized. Documentation will include identifying the type tester and the actual test result file.

3.11.2.2. All test results shall be documented per cable ID number.

3.12. Site Acceptance.

3.12.1. The final inspection will determine if a facility or system meets the specified technical and performance standards. It is held immediately after applicable communications infrastructure and/or system testing required for certification/acceptance. The assigned 45 SCS PM will authorize site acceptance by obtaining all required signatures on an AFTO Form 747. The site acceptance document will clearly document the results of all testing and list any exceptions. Site acceptance via AFTO Form 747 is required prior to final invoice.

3.13. **Contractor Deliverable/Submittal Items:** The following items shall be provided to 45 SCS PM for facility construction projects (modifying existing communications infrastructure) via AF Form 3000, Material Approval Submittal.

3.13.1. All BICSI training certification(s) (per paragraph 1.1.7.1.)

3.13.2. Communication System as-built drawings in Microsoft Visio format (per paragraph 3.10.2.1.)

3.13.3. Cable Test Reports (per paragraph 3.11.1.1.)

4. Physical, Personnel, and Technical Security Controls.

4.1. **Physical Security.** Physical security comprises physical measures designed to safeguard personnel; to prevent unauthorized access to equipment, facilities, material, and data; and to safeguard against espionage, sabotage, damage, and theft. Fire suppression, humidity controls, locks, guards, etc., all contribute to the security of Department of Defense (DOD) Information System (IS) and the missions they support. All physical and environmental controls must be established IAW Department of Defense Instruction (DODI) 8500.2. Some basic physical security controls are listed below.

4.1.1. Physical Access Control for Areas Containing Sensitive Information. Access to every office, computer room, and work area containing sensitive information (SI) must have physical restrictions so that access is granted only to those personnel who have a need for such access. Restrictions may be imposed by various means, such as having appropriately programmed Smart Cards or rooms physically locked, with the keys held by the manager responsible for its security. Authorized and specific knowledgeable personnel shall accompany outside consultants during upgrades/maintenance of the equipment.

4.1.2. Testing Physical Access Controls Forbidden. Employees must not attempt to enter restricted areas or buildings for which they have not received access authorization. Violators shall be tracked and liable for legal action.

4.1.3. Physical Security of Storage Media. All information storage media (e.g., hard disk drives, flash drives, zip drives, magnetic tapes, and CD-ROMs) containing SI must be physically secured. In case of loss due to theft or negligence, appropriate action should be taken to avoid compromising data and information.

4.2. **Personnel Controls.** The following personnel controls must be implemented to ensure that Industrial Control Systems (ICS) environments are operated and maintained in a secure, controlled manner such that data and other connected systems are appropriately protected:

4.2.1. Appropriate security offices conduct personnel security investigations for all functional users (civilian, military and contractor employees), when necessary.

4.2.2. Registration of all users by systems administrators, information assurance (IA) officers, or the specific information owners.

4.2.3. Specified system and/or application permissions that only allow access to required, need-to-know information.

4.2.4. Unique user ID and password for all users.

4.2.5. Specific system training.

4.2.6. Initial and annual refresher information security and awareness training.

4.2.7. Completed DD Form 2875, System Authorization Access Request (SAAR), (or equivalent) for system users, when required.

4.3. **Technical Security Controls.** In addition to the above personnel controls, the following technical security controls must be implemented in ICS enclaves:

4.3.1. Categorize all system data as sensitive or unclassified and safeguard accordingly.

4.3.2. Test and formally approve all system changes prior to implementing in the operational ICS environment (e.g., establish a risk management program, perform regular security reviews) and implement corrective actions/countermeasures.

5. Administration.

5.1. **Requirements and Specifications Administration.**

5.1.1. The base communications squadron commander or their appointed representative must keep records and other documentation pertaining to the design, layout and specifications of telecommunication pathways, spaces and cabling systems IAW RDS, AFI 10-404 or the current publication of ANSI/TIA/EIA-606-A.

5.1.2. The base communications squadron commander or their appointed representative must establish a complete and systematic means of tracking static and dynamic elements of the telecommunications infrastructure to include procedures for the ongoing administration of the telecommunications system.

5.1.3. The base communications squadron commander or their appointed representative must provide all pertinent documentation on administration to on-site personnel, representing the building owner or agent to include access authorizations to communications rooms and enclosures, when the project is completed.

NINA M. ARMAGNO, Brigadier General, USAF
Commander

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

AFI 33-150, *Management of Cyberspace Support Activities*, 30 November 2011

AFPD 33-1, *Information Management*, 27 June 2006

ANSI/EIA/TIA 568 – Commercial Building Telecommunications Cabling

ANSI/EIA/TIA 569 – Commercial Building Standard for Telecommunications Pathways and Spaces

ANSI/EIA/TIA 606 – The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

ANSI/EIA/TIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

TSB-67 – Transmission Performance Specifications for field testing of Unshielded Twisted-Pair Cabling Systems

TSB-75 – Additional Horizontal Cabling Practices for Open Offices

BICSI – Telecommunications Distribution Methods Manual

National Fire Protection Association (NFPA)

NFPA 70 National Electric Code

NFPA 10 Life Safety Code

American National Standards Institute (ANSI)

ANSI C2 National Electric Safety Code

Rural Electrical Association (REA)

REA PE-80 Gas Tube Surge Arresters

Unified Facilities Criteria UFC-3-580-01- Telecommunications Building Cabling Systems Planning and Design

Unified Facilities Guide Specifications (UFGS) 26 20 00 – Interior Distribution System

Unified Facilities Guide Specifications (UFGS) 27 10 00 – Building Telecommunications Cabling System

Unified Facilities Guide Specifications (UFGS) 27 51 16 – Radio and Public Address System

Engineering Technical Letter (ETL) 02-12 – Communications and Information System Criteria for Air Force Facilities

Engineering Technical Letter (ETL) 11-12 – Grounding, Bonding, Testing, and Recordkeeping for Communications Facilities

Adopted Forms

AF Form 847, *Recommendation for Change of Publication*

Abbreviations and Acronyms

A—Ampere

AFF—Above Finished Floor

AFI—Air Force Instruction

AFPD—Air Force Policy Directive

AC—Alternating Current

AFMAN—Air Force Manual

AFRIMS—Air Force Records Information Management System

ANSI—American National Standards Institute

BALUN—Balance to Unbalance

BICSI—Building Industry Consulting Service International

CATV—Cable Television

CDRL—Contractor Deliverable Items

CD—ROM – Compact Disc Read Only Memory

CES—Civil Engineering Squadron

CSIR—Communications Systems Installation Records

C2—Command and Control

DOD—Department of Defense

DODI—Department of Defense Instruction

EES—Earth Electrode Subsystem

EIA—Electronic Industries Alliance

EMT—Electrical Metallic Tubing

ETL—Engineering Technical Letter

GE—Grounding Equalizer

HVAC—Heating, Ventilation, & Air Conditioning

IA—Information Assurance

IAW—In Accordance With

ICS—Industrial Control Systems

ID—Identification

IDC—Insulation Displacement Connection

IS—Information System

LAN—Local Area Network

LMR—Land Mobile Radio

MAJCOM—Major Command

NEXT—Near-End Cross-Talk ()

NFPA—National Fire Protection Association

OPR—Office of Primary Responsibility

OSP—Outside Plant

PIC—Polyethylene Insulated Conductor Cable

PM—Project Manager

PoE—Power over Ethernet

PSELFEXT—Power sum ELFEXT

PSNEXT—Power sum near-end crosstalk

RDS—Records Disposition Schedule

SAAR—System Authorization Access Request

SCADA—Supervisory Control and Data Acquisition

SI—Sensitive Information

SCS—Space Communications Squadron

SW—Space Wing

TIA—Telecommunications Industries Association

TBB—Telecommunications Bonding Backbone

TGB—Telecommunications Grounding Busbar

TMGB—Telecommunications Main Grounding Busbar

TR—Telecommunications Room

UFC—Unified Facilities Criteria

UFGS—Unified Facilities Guide Specifications

UPS—Uninterruptible Power Supply

UTP—Unshielded Twisted Pair

VoIP—Voice over Internet Protocol

WAP—Wireless Access Point