BY ORDER OF THE COMMANDER

50TH SPACE WING INSTRUCTION 33-105

1 SEPTEMBER 2003

Communications and Information

C4 SYSTEMS INSTALLATION STANDARD

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

NOTICE: This publication is available digitally on the AFDPO WWW site at: **http://www.e-publishing.af.mil.**

OPR: 850 SCS/SCYC (Gary L. Curtis)
Supersedes 50SWI 33-105, 03 Jan 2000

Certified by: 850 SCS/CC (Lt Col Meyers)
Pages: 58
Distribution: F

This instruction implements AFPD 33-1, *Command, Control, Communications, and Computer (C4) Systems*. It establishes standards for installation of technical equipment and facility interfaces at Schriever Air Force Base (SAFB). It applies to all agencies performing work at SAFB, regardless of command. It outlines the specific electrical, mechanical and structural standards that alterations, modifications and installations of communications systems must follow. By implementing these standards, SAFB shall be able to maintain safe installations as well as accurate documentation of those installations. This standard will be applied to 50 SW Geographically Separated Units (GSUs) and/or Remote Tracking Stations (RTSs) in the future. When directed to implement this standard the GSU/RTS commanders will provide a supplement to this publication indicating which portions are applicable to their C4 installations. Send comments and suggested improvements on AF Form 847, *Recommendation for Change of Publication*, through channels to 850 SCS/SCYC, 300 O'Malley Avenue, Suite 30, Schriever AFB, CO 80912. The use of a name or trademark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

NOTE: In the event an installation proposal or a manufacturer's recommended specifications are in conflict with the requirements of this document, the 850 SCS Configuration Management Office shall determine the requirement for compliance.

An installing agency proposing to deviate from the standards and requirements stated herein shall submit a waiver request in writing to the Configuration Management Office. Large-scale deviations from this document must be addressed through a Memorandum of Agreement (MOA) with the appropriate installing agency or program office.

SUMMARY OF REVISIONS

This entire document has been significantly revised and updated. Updates reflect changes to Configuration Management Office policy and procedures and industry standards.

Chapter 1

INTRODUCTION

Section 1A—General.

1.1. Purpose. This document identifies and establishes the standards and requirements necessary for the uniform installation of technical equipment and facility interfaces to achieve effective site integration and configuration management of those areas and facilities under configuration management.

1.1.1. The first chapter of the document outlines the roles and responsibilities of integration management participants. The second chapter describes the site integration environment and standards that apply uniformly to all installations in facilities and areas under configuration management.

1.2. Scope. A wide spectrum of standards and directives apply to agencies that perform installations on SAFB. In addition to those standards, this publication establishes installation standards and requirements that are specific to areas under configuration management on SAFB. In the event of conflict between this publication and other standards, the document with the strictest requirement, as determined by the Configuration Management Office, shall prevail.

1.2.1. This C4 Systems Installation Standard (SIS) applies to contractors and organizations that design, produce, install, test, or modify specific areas of the technical facilities, equipment, and systems that constitute the SAFB Configuration Baseline. The SAFB Configuration Baseline incorporates all facilities and areas under configuration management on SAFB (**Attachment 3**, Section D).

Section 1B—Installation Responsibilities.

1.3. General. Various agencies have certain responsibilities for technical equipment installations. The responsibilities described below are pertinent to this document:

1.3.1. Configuration Management Office. Responsibilities of the Configuration Management Office include:

1.3.1.1. Coordination of facility modifications for equipment installations.

1.3.1.2. Reviewing, evaluating and approving installation design documentation.

1.3.1.3. Providing equipment reference designation and cable designators.

1.3.1.4. Coordinating interface between diverse operational systems.

1.3.1.5. Approving waivers of the requirements described in this document.

1.3.1.6. Reviewing and approving revisions to the SAFB SIS.

1.3.1.7. Coordinating and advising on new designs or hardware design modifications that impact SAFB facilities under configuration management.

1.3.1.8. Supporting subsystem and system-level testing that may result in impacts to SAFB facilities under configuration management.

1.3.2. Modification Requesting Agencies. Each requesting agency shall accomplish the following prior to performing any installations, de-installations or modifications:

1.3.2.1. Submit a Reservation/Removal Request (RRR) to the Site Integration I/MAR helpdesk for any installation or modification that impacts floor space, rack space, or electrical power.

1.3.2.2. Submit a completed 50 SW Form 19 Package to the Site Integration I/MAR helpdesk. (Note: The installing agency is responsible for coordinating with the affected offices or organizations prior to submission of the 50 SW Form 19, to ensure the installation or modification does not hinder the day-to-day operations or missions). Requests for waiver or deviation from the requirements described in this document shall be submitted to the Configuration Management Office.

1.3.2.3. Coordinate planned installations with the SAFB Emissions Security (EMSEC) manager, 50 SCS/SCBI. In accordance with AFI 33-203, it is the requester's responsibility to ensure their facility meets established EMSEC criteria.

1.3.2.4. Coordinate all structural and physical building requirements with 50 CES via an AF Form 332, Base Civil Engineer Work Request.

1.3.2.5. Submit requests for waiver or deviation from the requirements described in this document to the Configuration Management Office.

1.3.2.6. Ensure that the installing agency marks and labels communication cables and equipment with numbers assigned by Cable Management and the TAID section respectively.

Chapter 2

SITE INTEGRATION ENVIRONMENT

Section 2A—General.

2.1. Purpose. This chapter describes the general site integration environment and standards that are uniformly applied to facilities under site integration configuration management throughout SAFB.

Section 2B—Utilidor.

2.2. General. The utilidor (illustrated in **Figure 2.1.**) is used primarily for installation and distribution of communications cables and utilities between Engineering & Administration (E&A) (building 300), Operations (building 400), National Reconnaissance Office (NRO) operations (building 401), Site Support (building 500), Central Plant (building 600), and Joint National Integration Center (JNIC) (buildings 720 and 730). Conduit and cable trays have been provided in the utilidor to support installation of communications cables.

Section 2C—Exterior Duct Banks and Underground Cables.

2.3. Cable Distribution. Distribution of communications and utility lines between buildings and facilities not connected by the utilidor will be routed, at Cable Management's discretion, through the utilidor to the exterior manhole or handhole duct bank system. Cables extending from the SAFB duct bank shall be installed per Base Civil Engineer (BCE) and Configuration Management Office specifications.

Section 2D—Physical Alterations to Facilities.

2.4. SAFB Facilities Under Configuration Management Alteration Policy.

2.4.1. Raised-Floor Penetrations. Raised-floors are provided in technical equipment areas to facilitate cable routing and cooling air distribution. **Figure 2.2.** illustrates the typical under floor configuration in building 400.

2.4.1.1. Penetration Criteria. Openings in the raised-floor shall be made only after coordination and approval of the Configuration Management Office.

Figure 2.1. Utilidor Plan.

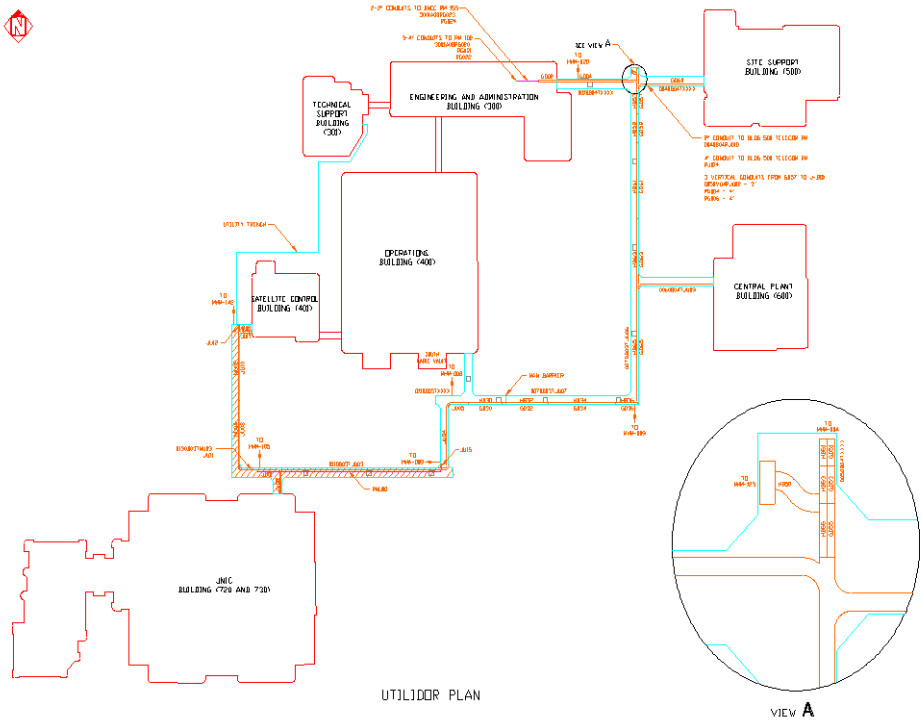
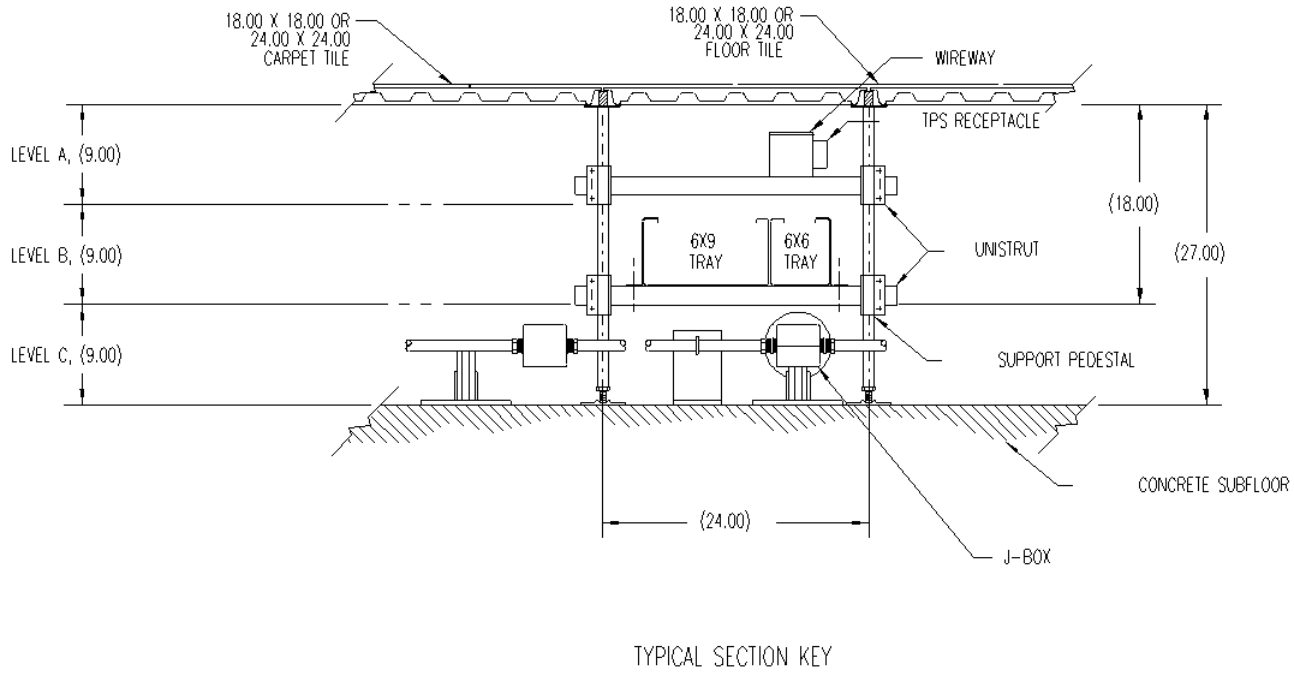


Figure 2.2. Typical 27 inch Under-floor Section.



NOTE:

THE AREA BENEATH THE RAISED FLOOR GRID IS SHOWN IN THREE (3) EQUAL HORIZONTAL LAYERS. EACH APPROXIMATELY 9 INCHES DEEP. 'LEVEL A' EXTENDS DOWNWARD FROM THE UNDERSIDE OF THE RAISED FLOORING TO THE DEPTH OF APPROX 9 INCHES. 'LEVEL B' CONTINUES BENEATH 'LEVEL A' TO THE DEPTH OF APPROX 18 INCHES. 'LEVEL C' CONTINUES BENEATH 'LEVEL B' TO THE CONCRETE SUB-FLOOR, APPROXIMATELY 27 INCHES BELOW THE RAISED FLOORING.

'LEVEL A' IS RESERVED FOR POWER, WIREWAYS, AND RECEPTACLES.

'LEVEL B' IS RESERVED FOR SIGNAL CABLE CONVEYANCES.

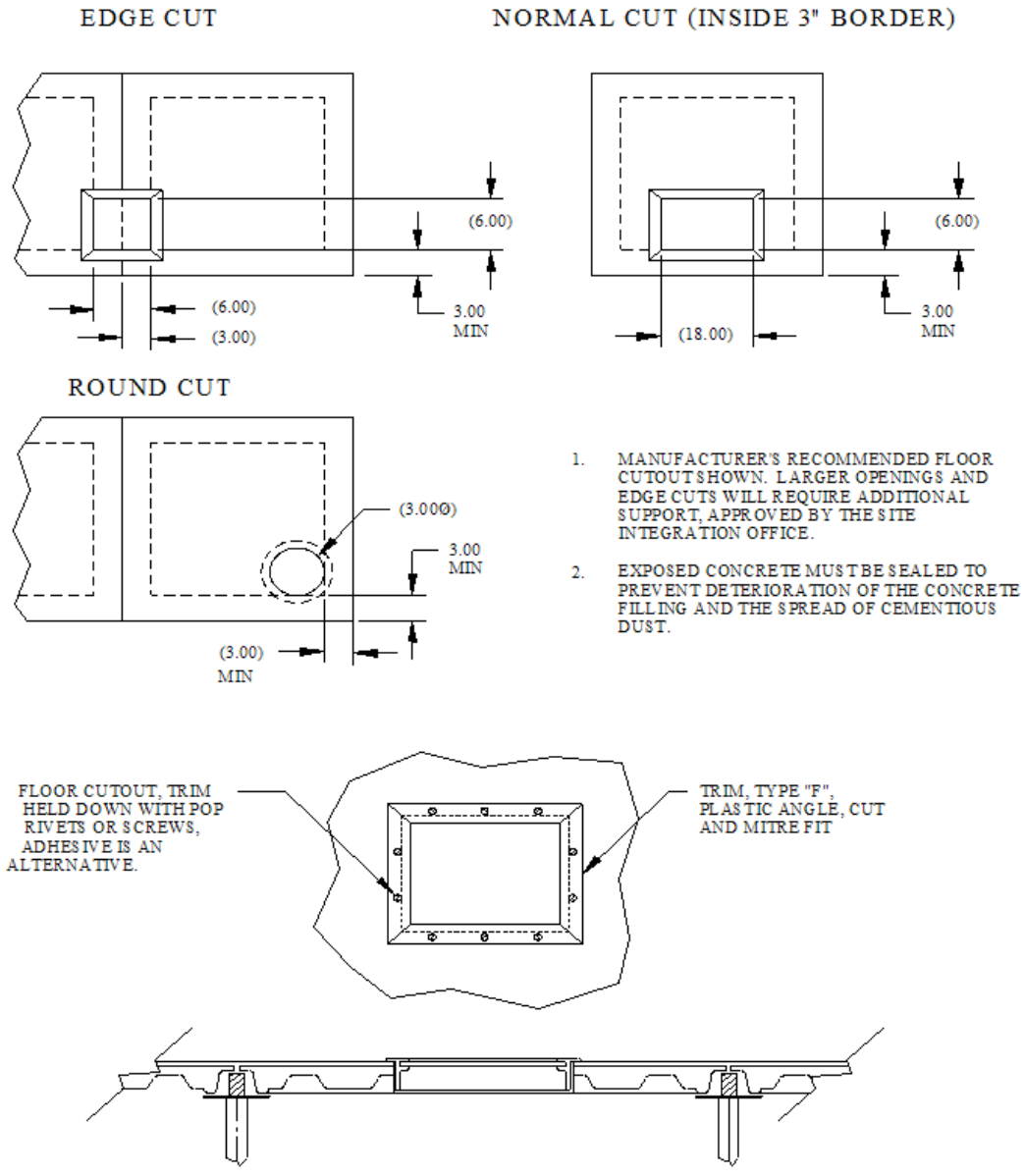
'LEVEL C' IS RESERVED FOR GROUND EXTENSIONS, POWER DISTRIBUTION IN CONDUITS (FEEDERS FROM MAIN TO SUBPANELS AND FROM WIREWAYS TO RECEPTACLES) AND ADMINISTRATIVE COMMUNICATIONS CABLES ROUTED IN "D" RINGS.

WHEN INSTALLING SITE PREP AND OTHER UTILITIES DEVIATING FROM THE ABOVE STANDARD, A WAIVER ON THE FORM 19 IS REQUIRED. TRANSITIONS BETWEEN LEVELS MAY BE MADE TO AVOID OBSTRUCTIONS WITHOUT A WAIVER.

2.4.1.2. Penetration Requirement. Raised-floor openings shall be reinforced per manufacturer's recommendations to preserve floor-loading characteristics and to prevent adverse impacts to the Air Conditioning (AC) system.Raised-floor cutouts shall be sealed with an approved material to prevent dusting of the exposed concrete core and lined with a material suitable to cover exposed sharp edges and provide protection to cable or other hardware passing through the opening. (Rubber-coated flex conduit may be used without this lining, as the conduit will provide adequate protection.) All openings shall be sealed with an UL-listed material, apllied per manufacturer's specifications, to prevent degradation of the AC system (i.e., in tumescent composite sheet with putty, putty alone, fire sealant expanding foam, or other Air Force approved material). The use of a property applied UL-sealant will ensure AC pressure is not adversely impacted. Neoprene (synthetic rubber) is not an acceptable material. **Figure 2.3.** depicts a typical treatment of edges on a raised-floor opening. **Figure 2.4.** depicts the installation of a typical composite sheet material.

2.4.1.3. Reconstruction. In the event that maintenance or work is performed that requires the raised-floor system to be disrupted, it is the responsibility of the performing agency to return the raised-floor system back to its original configuration immediately after the work is complete.

Figure 2.3. Raised Floor Cutout and Trim.



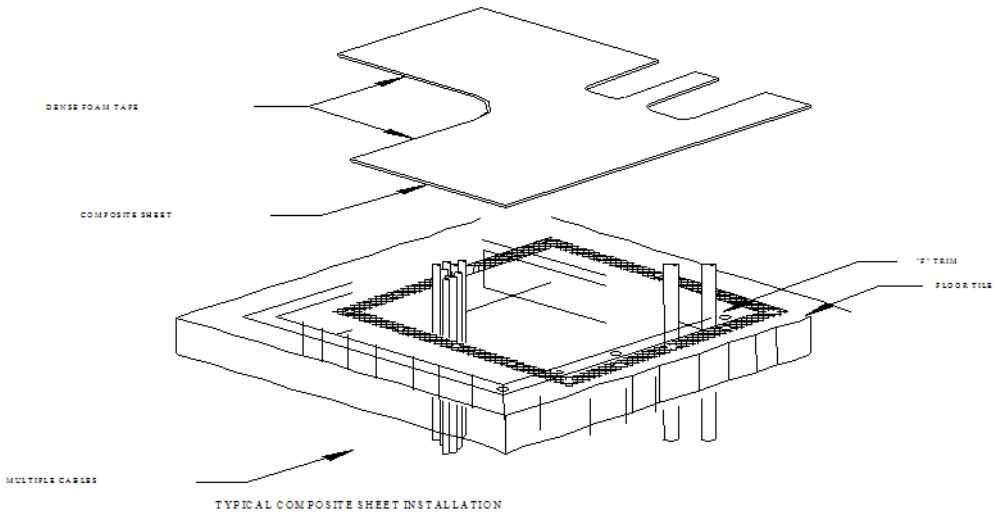
NOTES:

1. Any rubber inserts that exist are to be removed from the cable opening.

2. If possible, arrange cables together. If cables cannot be arranged together, the cables are to be left in place. Pre-cut composite sheet prior to installing as shown in the above drawing. Sheet should be cut to overlap the cable opening by two inches, if possible. The cable holes in the sheet should be cut a minimum of one-inch larger than necessary to allow for future cable expansion.
3. Install "F" trim around the perimeter of the cable opening as shown above. Trim is held down with pop rivets or screws. Adhesive is an alternative.
4. Place composite sheet foil side down inside the "F" trim slot with a bead of moldable putty applied around the edges. To seal EMI or RFI racks use a silicone adhesive to secure composite sheet to the bottom of the rack.
5. Apply the dense foam tape around all the rough cut-out edges to protect the cable from being cut.

After the composite sheet is in place fill all remaining openings and gaps with moldable putty to obtain a snug fit around the cables and complete the seal.

Figure 2.4. Typical Composite Sheet Installation.



2.4.2. Firewall Penetrations. Installing agencies are responsible for ensuring that firewall integrity is maintained when penetrating for communications or power cables. There are three approved methods to penetrate unshielded firewalls: Multi-Cable Transit devices, Compression Fittings, and Conduit Penetrations. These methods are described below.

2.4.2.1. Multi-Cable Transit (MCT). The Nelson Electric Supply MCT (also known as Nelson Window) is an example of MCT penetration device permitted at SAFB. Other MCTs that meet the rating of the penetrated firewall may be used. MCTs are normally rated for a two-hour firewall. At

SAFB, the primary use of MCT is to provide cable penetration between the vertical and horizontal cable chases. Additionally, MCTs may be used when penetrating through a gypsum firewall where numerous cable changes are anticipated. All penetrations must be capped by the installing or removing agency when not in use.

2.4.2.2. Compression Fitting (CF). The Crouse-Hinds Sealing Gasket Assembly and the Service Entrance Cable Connector are examples of CFs permitted at SAFB. Other CFs that have a one-hour fire rating may be used. CFs are used for penetrating metal windows located between the horizontal cable chases and the under floor areas of the modules/rooms. Flame Seal II Putty, manufactured by Nelson Electric Supply, or equivalent, shall be used at the fitting if a complete seal cannot be accomplished. The manufacturer's instructions shall be followed when using CFs.

2.4.2.3. Conduit Penetration (CP). Only rigid conduit or electrical metallic tubing (EMT), as specified in this document, shall be used. CPs are used for penetrations through gypsum firewall. The procedures for making and sealing these penetrations are:

2.4.2.3.1. Cut a hole in the firewall approximately one-inch larger than the diameter of the conduit.

2.4.2.3.2. Pack fiberglass insulation into the gap around the conduit.

2.4.2.3.3. Use tape to hold the fiberglass insulation in place. Putty or caulk over the tape to complete the seal.

2.4.2.3.4. Use Flame Seal II Putty, or equivalent, to completely seal around the cables in one end of the rigid conduit or electrical metallic tubing.

NOTE: For under floor firewall penetrations, Flame Seal II Putty may be used as a substitute for the fiberglass, tape, and putty/caulk as described above.

2.4.3. Additional Requirements For Penetrating Firewalls. Shielded modules were provided in building 400 during CSOC activation. Current 50 SW operations located on SAFB do not require EMSEC-shielded modules. Maintenance of the existing shields, shield doors and shield effectiveness testing is not required. Individual programs must meet TEMPEST requirements in accordance with Air Force Cryptologic Support Center (AFCSC) guidance. The following sections describe penetrations through shielded modules.

2.4.3.1. Unused Penetrations. Unused penetrations made by means of a wave-guide, bulkhead connector or other device shall be capped or covered to prevent loss of under floor cooling air.

2.4.4. Shielded Area Penetration Criteria. Cables that penetrate a shielded area shall do so in a way that shall minimally degrade the physical integrity of the shield. Every penetration shall have its design submitted to the Configuration Management Office for review and approval prior to installation. Installations shall comply with the National Electric Code (NEC) NFPA 70, Article 300-21, AFMAN 33-214 VOL 2 and NFPA 75.

Section 2E—Equipment Placement.

2.5. General. Guidelines and requirements for equipment and systems furniture placement are outlined in this section.

2.5.1. Movable Partitions and System Furniture Walls. Modular partition walls and system furniture walls generally subdivide Technical/mission areas and modules. Re-location of movable partitions and system furniture walls shall not be made until a plan for reconfiguration has been submitted to and coordinated with the Configuration Management Office, BCE architect and 50 SW/SE. Drawings for the system furniture shall include panel sizes, powered panels, non-powered panels and power feed locations.

2.5.1.1. Equipment and System Furniture Layout. The Configuration Management Office shall manage the floor layout and configuration for equipment areas and system furniture within the SAFB Configuration Baseline. The agency having Modification Control Board (MCB) authority for an area or module approves the allocation of floor space within the area (i.e., 1 SOPS for SOC-31, 50 SCS for the Mission Communications Segment, and the Air Force Network Control Center (AFNCC)).

2.5.1.1.1. Each requesting agency shall furnish the Configuration Management Office with drawings of the proposed placement of equipment and system furniture to be installed. Equipment and system furniture installation shall not proceed until the equipment and system furniture layout has been coordinated with the Configuration Management Office. Drawings shall conform to the requirements described below.

2.5.1.2. Coordinate System. Drawings shall illustrate the location of equipment/system furniture within a Cartesian coordinate system that is overlaid on an outline of the area where the installation is to be made. The grid location D, O/5,3 designates column letter D, floor grid letter O and column number 5, floor grid number 3. Equipment locations shall be referenced from the most northeast corner of the equipment footprint.

2.5.1.2.1. Grid lines of the coordinate system shall be spaced at two-foot intervals.

2.5.1.2.2. For installations in raised-floor areas, the grid lines shall coincide with the outlines of the raised-floor panels.

2.5.1.2.3. An origin and enumerated axis shall be marked for each coordinate system.

2.5.1.2.4. All coordinate systems shall be clearly referenced to an existing building column line, as defined by the Technical Area Integration Drawings (TAIDs), or the Holmes and Narver Drawings for areas that have no TAID.

NOTE: Reference **2.6.1.2.** and **2.6.4.3.2.** regarding devices affected by system furniture alterations. Electrical requirements for systems furniture are covered in **2.7.6.**

2.5.1.3. Raised-Floor Openings. Drawings shall show the location and size of openings to be made in a raised floor.

2.5.1.4. Scale. A minimum scale of 1/64-inch equals one foot is recommended for layout drawings. Where necessary, greater detail or other DoD drawing standards may be used.

2.5.1.5. Countermeasure Level. Each module or room at SAFB that processes classified information has an established countermeasure level. The counter-measure level, assigned by the base EMSEC office, may restrict the placement of equipment, telephones and cables. Equipment placement must meet RED/BLACK separation requirements of AFMAN 33-214 VOL 2.

2.5.1.6. Equipment Identification. Equipment that has one or more of the following: a communications cable connection, is powered by UPS power, has a dedicated power circuit, or requires

floor supports, shall be given an equipment identification number prior to installation. The equipment shall be labeled in accordance with **Attachment 2**, Section B of this document.

2.5.2. Floor Loading. Equipment shall not impose floor loads that exceed the allowable loads for raised and non-raised floors in the baseline areas.

2.5.2.1. Raised-Floor Areas. The maximum floor loading on tiles in raised-floor areas shall not exceed 250-pounds per square foot (psf) or 1,000-pound point loading. Concrete floor-slabs that support raised floors may be loaded to a maximum of 200-pounds per square inch (psi). Where individual equipment loads exceed 250-psf, or when several pieces of heavy equipment are located in close proximity, additional under floor bracing shall be added. Four-, five-, and six-drawer safes shall have floor reinforcement. Safes and equipment that require floor reinforcement shall be given equipment ID numbers per paragraph **2.5.1.6.** and be labeled IAW **Figure 2.5.**

2.5.2.2. Non Raised-Floor Areas. The maximum floor loading in non raised-floor areas shall not exceed 60-psf.

2.5.3. Equipment Installation Tolerances. Equipment shall be installed plumb, aligned and anchored in accordance with AF TO 31-10-29, Erection and Assembly of CEM Equipment.

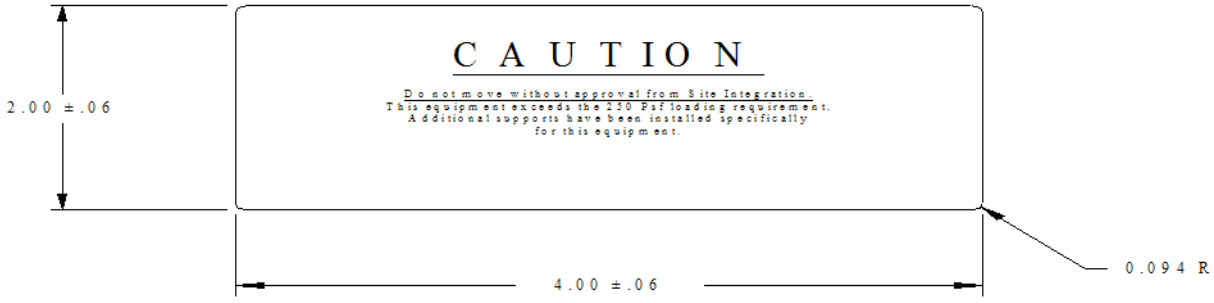
2.5.4. Overhead Equipment. The structural steel beams above the suspended ceiling shall support equipment requiring overhead mounting (i.e. Time Display Units or television monitors). Ceiling support wires or the suspended ceiling grid will not be used to support the overhead equipment.

2.5.5. Safety Requirements. Equipment Layout. To ensure a safe working environment, communications cables, power wiring, and ancillary cables that penetrate raised floors shall do so entirely within the footprint of the respective equipment rack.

2.5.5.1. Unistrut End Cap Covers. Under floor unistruts shall have end cap covers installed to protect against sharp edges.

2.5.5.2. All equipment and system furniture installations shall comply with NFPA 101, Life Safety Code.

Figure 2.5. Reinforcement Marking.



Section 2F—Mechanical System Standard

2.6. General. This section provides environmental standards and requirements.

2.6.1. Interior Environmental Condition. Data-processing equipment areas are provided with a controlled internal environment to meet equipment-operating specifications and ensure reliable equipment operation. The module areas in building 400 and 700 use pressurized, raised-floor plenum systems to deliver cooling air for specific data-processing equipment. Technical equipment in other areas normally receives cooling air from overhead systems. The environmental system is controlled by BCE deviations from the following guidance requires BCE approval.

2.6.1.1. Environmental Parameters. Air conditioning systems in data-processing equipment areas are provided to satisfy equipment cooling requirements rather than creature comfort and shall maintain the environmental parameters specified in the respective FIS sections.

2.6.1.2. Due to the criticality of airflow in building 400 and 700 modules, only two floor tiles shall be removed at any given time for access to under floor areas in modules that support an operational mission. This constraint may be relaxed if suitable air dams are approved by BCE or if non-impact to under floor cooling in the module can be demonstrated.

2.6.1.3. Requirements Affecting Mechanical Systems. Heat load calculations must be performed when changing power panel loads or when planning the relocation of computer equipment. These calculations shall show whether changes to mechanical systems are required. Floor registers may not be abandoned in place. HVAC requirements must be addressed in the 50 SW Form 19 package if any of the following situations apply:

2.6.1.3.1. Any change to power panel loads. (This change may affect floor register layout.)

2.6.1.3.2. Any change to wall configuration. (This change may affect overhead cooling and heating, fire protection and fire detection.)

2.6.2. Underfloor Air Distribution System.

2.6.2.1. General Description. Conditioned air is supplied by a combination of variable air-volume overhead and underfloor air-handling units. Computer room air conditioning units are used only where the capacity of the underfloor air-handling unit is not adequate. Airflow from an underfloor plenum varies in response to a thermostat; air-volume controlled, pneumatic-operated dampers on the floor air registers; or through the use of restricting plates, as described in **2.6.2.4.**

NOTE: Underfloor air-handling equipment in building 400 is redundant and must be used for data-processing equipment cooling. Overhead air conditioning is not redundant.

2.6.2.2. Raised Floors. The modules in building 400 and the operations and equipment areas in building 700 are provided with raised floors for distribution of cooling air to the equipment.

2.6.2.3. Direct Air Intake. Direct underfloor or under-rack cooling shall be used only if ambient cooling is shown to be impractical to satisfy a manufacturer's specifications for cooling the equipment or rack with internally powered fans. Penetrations for such installations shall conform to the requirements of **2.4.1.** of this document.

2.6.2.4. Under-Rack Floor Dampers. Under-rack pneumatic-controlled dampers (see **Figure 2.6.**) may be used if direct cooling is required. The control dampers shall be connected to the Emergency Power Off (EPO) switch. The dampers shall "fail open" upon loss of air pressure. Set points

shall be determined according to the maximum calculated design load encountered. The minimum flow to establish positive airflow through a computer rack is 40 cubic feet per minute (cfm). Due to rack design variations, this flow rate does not guarantee that flow stagnation shall not happen within the rack.

2.6.2.5. Floor Registers. Floor registers (see **Figure 2.7.** and **Figure 2.8.**) shall be 6 inches by 18 inches, mounted only one per floor tile, have a room thermostat controlled damper, be directional at 30° deflection, and be flush mounted. A minimum of 240-cfm can be expected for each full-open register. All new floor registers shall be heel proof. All floor registers not located under equipment racks shall fail in the closed position.

2.6.2.5.1. Pneumatic Tubing. Pneumatic tubing connected to the floor registers shall be 3/8 inch outside diameter (OD), fire resistant and UL-rated for air plenum application. Tubing shall be run on the concrete underfloor deck, attached at each floor tile pedestal via tie wraps every 10 feet. A maximum of six floor registers may be connected to any one pneumatic loop.

2.6.2.5.2. Computer Room Air Conditioners (CRACs). In building 400, a maximum of 80 registers per module can be installed without installing CRACs. If more than 80 registers are to be installed, a recalculation of the entire module heat load shall be made to verify the register configuration. **Figure 2.9.** illustrates a typical CRAC configuration.

2.6.2.5.3. A means to provide additional underfloor cooling air must be used if more than 80 floor registers are installed. Customarily, down-flow CRACs are provided. CRAC installation shall include smoke dampers and underfloor turning vanes. New CRACs shall have floor supports installed at the time of installation. CRACs shall be connected to the manual HVAC power off switch for each module in building 400, which is also identified as the Emergency Refrigeration Off (ERO) or Air Power Off (APO) switch. Hydraulic calculations of the building chilled-water system shall be provided to determine CRAC impact.

Figure 2.6. Typical Under-Rack Damper (Building 400).

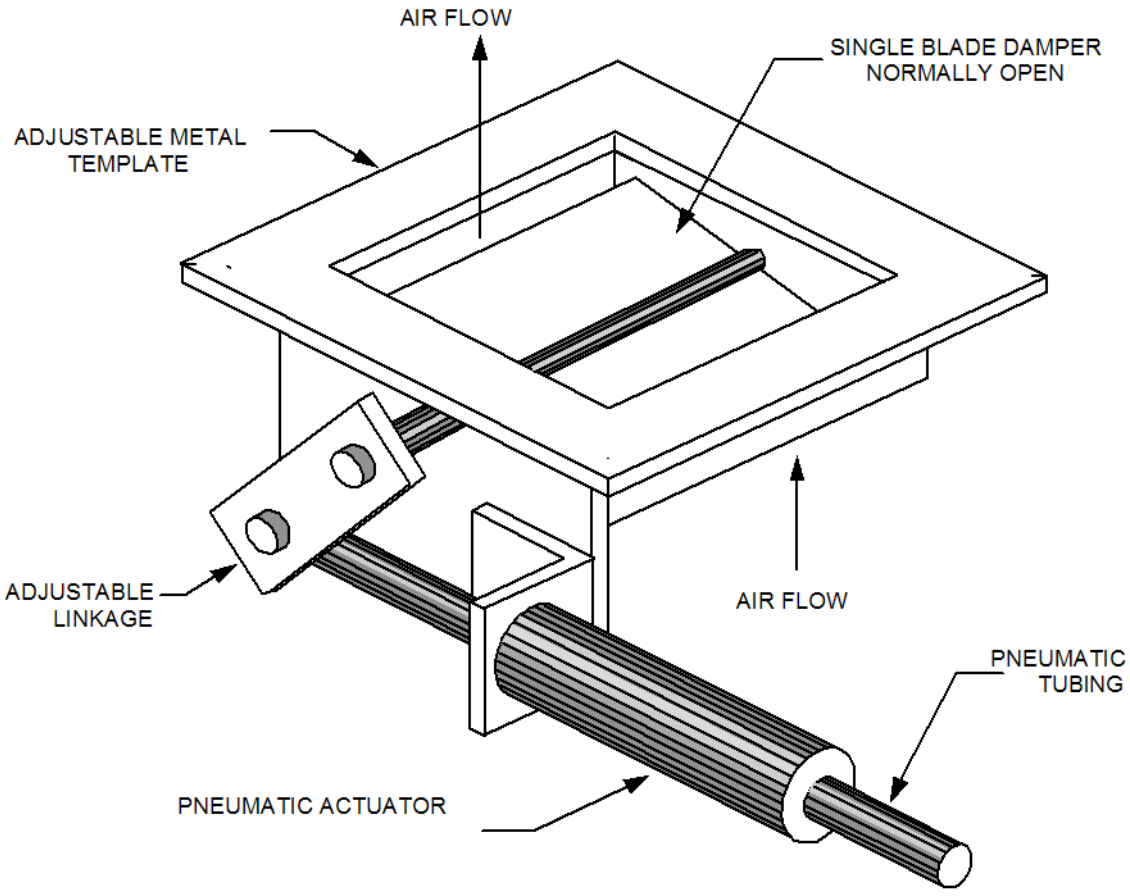


Figure 2.7. Typical Ambient Floor Register.

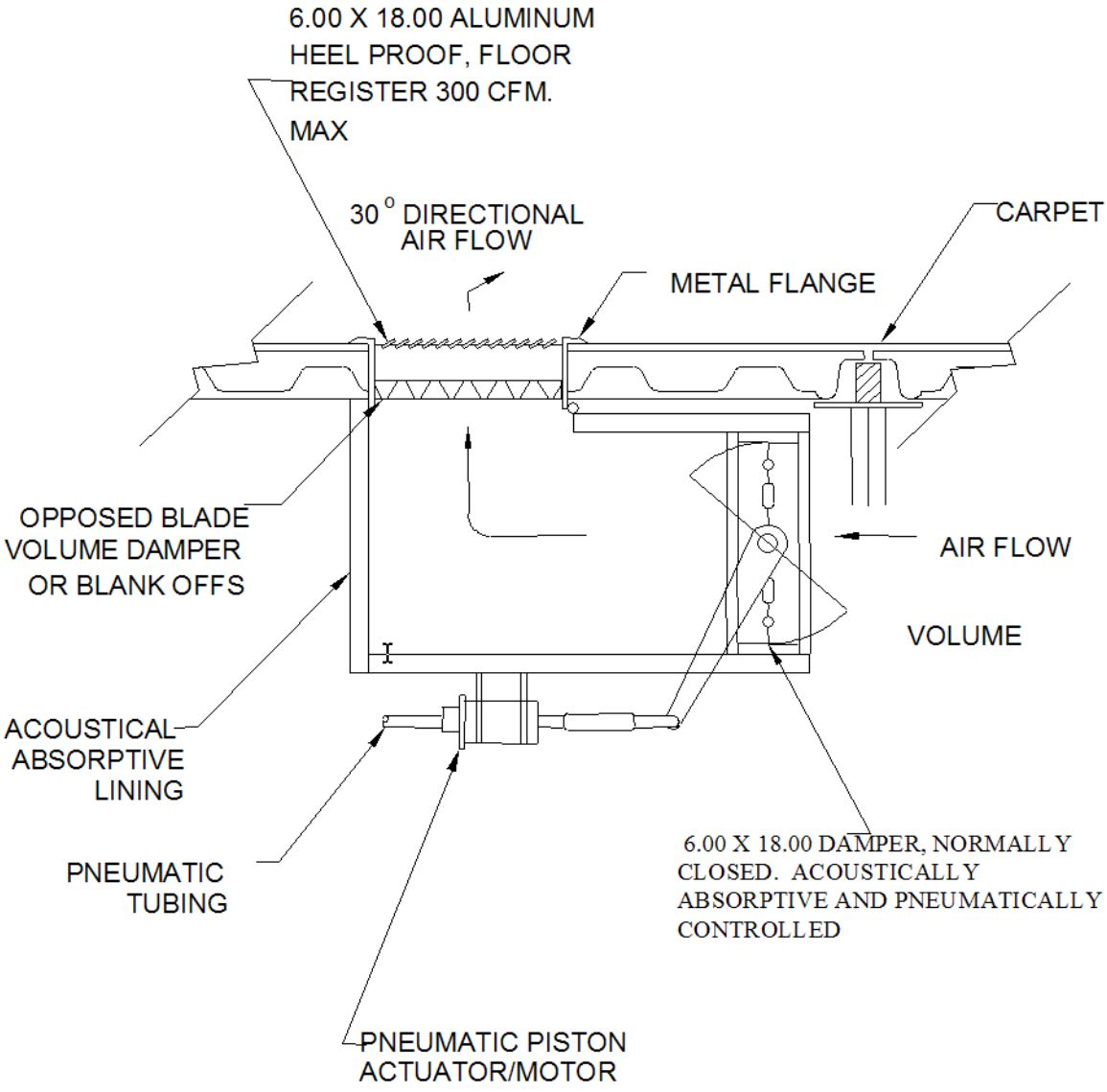
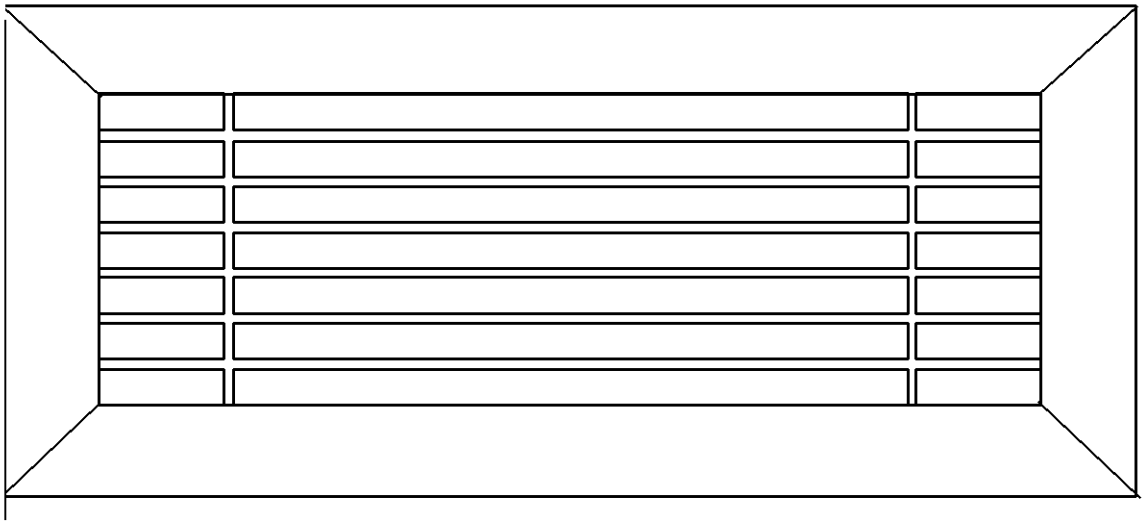


Figure 2.8. Typical Register.

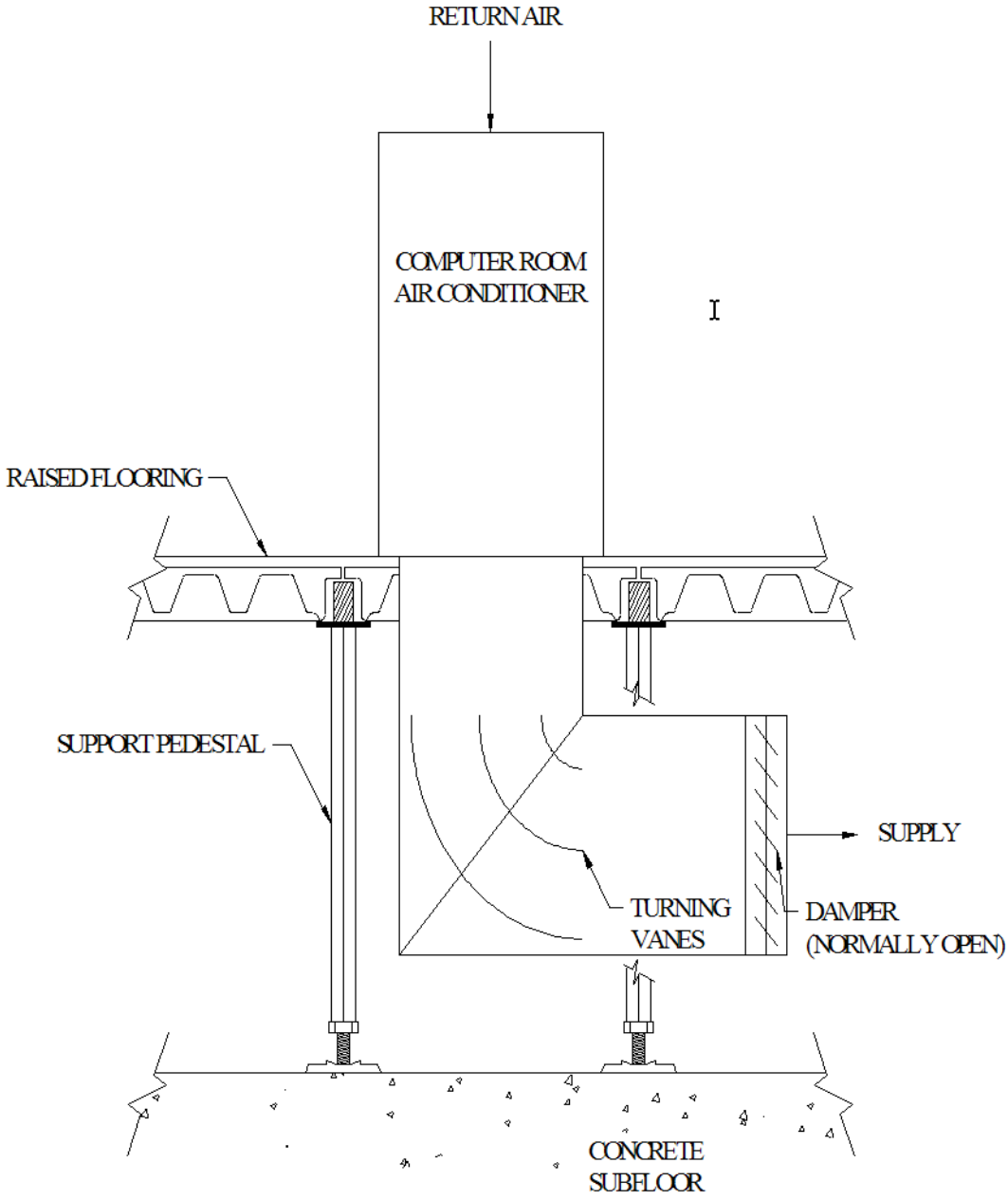


TYPICAL J & J REGISTER 2530PP
18 X 6 TYPE R & B FR 10

2.6.2.5.4. Coordination During Equipment Layout Planning. Coordination is necessary during equipment layout planning in order to ensure that the floor register layout is suitable, that there is a sufficient number of registers to satisfy equipment cooling requirements, and that the registers are designed to provide proper air flow. Details for the relocation of any registers shall be furnished to the Configuration Management Office and BCE. Any relocation of air registers must have an approved 50 SW Form 19 or field change.

2.6.3. (Reserved)

Figure 2.9. Typical CRAC Configuration.



2.6.4. Fire Suppression, Detection and Alarm Systems and Devices.

2.6.4.1. General Description. In general, fire suppression is provided by wet-pipe sprinkler systems or by the use of air-supervised, dry, pre-action sprinkler systems. Class 2 standpipe hose stations provide additional fire suppression capability

2.6.4.2. Sprinkler System Alterations. Alterations or extensions to existing sprinkler systems in any area shall be in strict accordance with NFPA 13, Standard for the Installation of Sprinkler Systems. Sprinkler heads proposed for installation or relocation shall be equivalent in model, type, rating and style to those in the surrounding area. Suspension of new cross-mains, branch lines or sprinkler heads shall also be in accordance with NFPA 13.

2.6.4.3. Detection/Alarm System.

2.6.4.3.1. Alterations. Renovations or additions to detection and alarm systems shall be made in strict accordance with NFPA 72, National Fire Alarm Code.

2.6.4.3.2. Affected Devices. As area expansions or renovations take place, including changes to floor-to-ceiling partition walls and systems furniture, consideration must be given to the necessity of relocating or installing any of the following:

2.6.4.3.2.1. EPO and APO switches.

2.6.4.3.2.2. Emergency Egress Lighting.

2.6.4.3.2.3. Sprinkler Heads.

2.6.4.3.2.4. Heat and smoke detectors.

2.6.4.3.2.5. Fire alarm pull stations.

Section 2G—Electrical Power Systems.

2.7. General. This section provides specific SAFB technical and technical support power requirements and standards. Installations shall be IAW NFPA 70, National Electric Code (NEC).

2.7.1. Technical Power System (TPS) Characteristics, AC and DC Systems.

2.7.1.1. TPS AC System.

2.7.1.1.1. General Description. The TPS AC system supplies electrical power to critical equipment loads. The critical loads require uninterrupted, regulated power at 60Hz and are provided power from an Uninterruptible Power System (UPS).

Nominal Voltage:	120/208V, 3-phase, 4-wire
Frequency:	60.0Hz
Voltage Regulation:	±2% with 50% phase unbalanced

2.7.1.1.2. Distribution System. In the TPS AC system, power is distributed from floor or wall-mounted main panels to wall-mounted sub-panels via an approved raceway. From sub-panels, individual conductors are brought via an approved raceway to power receptacles or junction boxes for direct connections. Under floor electrical receptacles will be isolated ground twist-lock type.

2.7.1.1.3. Load Balancing. All loads shall be balanced to the maximum extent possible to minimize current flow in the neutral conductor.

2.7.1.1.4. Load Criteria. The voltage from the TPS system shall not be connected to any motor generator, motor, or other rotating machine. The exceptions to this rule are the equipment rack fans for equipment racks or computer peripheral equipment.

2.7.1.2. TPS DC System

2.7.1.2.1. General Description. The TPS DC system supplies electrical power to critical communication equipment loads. The communication critical loads require uninterrupted, regulated power at -48 Volt DC, and are provided power from AC-to-DC rectifiers and backup batteries. Installations shall be IAW TO 31Z-10-22, Electrical Power Systems For Telecommunications Facilities.

2.7.1.2.2. Distribution System. In the TPS – 48 Volt DC system, power is distributed from rack mounted main panels to rack mounted sub-panels via an approved raceway. From sub-panels, individual negative (–) and positive (+) conductors are brought via an approved raceway to end communication equipment loads for direct connection, or to fused distribution units within the communication equipment racks.

2.7.1.2.3. System Characteristics. The 48-Volt DC power characteristics are as follows:

Nominal Voltage:	54 Volts DC, rectifier float voltage (normally supplies power load requirements and battery charging) 52 Volts DC, battery voltage – fully charged (supplies backup power load requirements)
Circuit wiring:	2-wire; negative (–) and positive (+)

2.7.2. General Description. The TSPS supplies electrical power to the essential facility loads. The normal power source is the local commercial utility. Standby Class B diesel generators back up utility power. The standby system is capable of meeting the power requirements of all critical and essential loads. Under floor receptacles will be twist lock type.

2.7.2.1. Distribution and Load Balancing. The requirements of distribution and load balancing for TSPS power shall meet the criteria of **2.7.1.1.3.**, Distribution System, and **2.7.1.1.4.**, Load Balancing for TPS.

2.7.2.2. Load Criteria. Most of the TSPS loads are motors and lighting that can tolerate momentary, in some cases extended, power outages without compromising the operational mission.

2.7.3. Classified Equipment Power.

2.7.3.1. Requirement. Electrical power for equipment processing classified information (RED) shall meet the installation criteria of AFMAN 33-214 VOL 2.

2.7.4. Power Cables and Conductors.

2.7.4.1. Cable and Conductor Requirements. The distribution of power shall be by jacketed multi-conductor cable or individual conductors. Cables and conductors shall be installed and routed through approved raceways. Cables shall have a fully rated or oversized neutral and a ground wire. Cables and individual conductors shall meet the following requirements.

2.7.4.1.1. 600 volt rating.

2.7.4.1.2. Maximum operating temperature of at least 90° Centigrade.

2.7.4.1.3. Suitable for damp or dry locations.

2.7.4.1.4. Flame retardant and heat-resistant thermoplastic insulation

2.7.4.2. Conductor Color Code. Power conductors of a standard "wye" configuration shall be color coded as follows:

120/208V	277/480V
Phase A – Black	Phase A – Brown
Phase B – Red	Phase B – Orange
Phase C – Blue	Phase C – Yellow
Neutral – White	Neutral – Gray or White
Ground – Green	Ground – Green

2.7.5. Power Distribution Systems

2.7.5.1. Local Power Distribution. Floor-mounted or wall mounted power distribution panels shall be installed for the purpose of providing localized power distribution. The physical location of such power distribution systems shall be determined by the installing agency. Each distribution system should be as close to the loads it serves as possible.

2.7.5.1.1. TPS and TSPS power conductors (feeders and branch circuits) shall not be installed in the same conduit, wireway or raceway.

2.7.5.2. Local Power Distribution Identification. Main and sub-panels shall be labeled with the panel number as assigned by 50 CES, or as assigned by the Configuration Management Office for panels in areas under configuration management control.

2.7.5.3. Sizing/Loading Policy for 60Hz Systems (TPS and TSPS). To ensure standardization of the NEC interpretations for sizing and loading the TPS and TSPS panels, the following criteria shall apply:

2.7.5.3.1. Panel main breakers shall be sized at a minimum of 125 percent of total nameplate load connected to the panel

2.7.5.3.2. Panel distribution breakers shall be sized at a minimum of 125 percent of the connected nameplate loads.

2.7.5.3.3. Distribution breakers from the main panel to the sub-panels shall be rated equal to or greater than the sub-panel main breaker (i.e., a minimum of 125 percent of the nameplate loads on the sub-panel).

2.7.5.3.4. When additional power is required and the criteria of **2.7.5.3.1.** – **2.7.5.3.3.** would be violated; a baseline determined by measurements may be applied in place of nameplate loads. The baseline shall be established by measuring the maximum continuous amps on each phase and the neutral conductors for at least 15 days. A new load may be added to a baselined panel if the new load (nameplate or measured load from an identical installation) plus the established baseline amps does not exceed 80 percent of the panel rating, panel bus rating, panel main circuit breaker trip rating and conductor wire size rating. If the total of the new load

plus the established baseline amps exceeds 80 percent of the panel ratings, a new baseline effort shall be conducted using the 15-day measurement period. Measurements shall be taken in amps using true Root-Mean-Square (RMS) measuring equipment.

2.7.5.3.5. Multiply the baseline maximum amps (see **2.7.5.3.4.**) by 1.1 (110 percent) to establish the calculated minimum demand load in amps.

2.7.5.3.6. All new panels shall be sized at 125 percent of the new nameplate loads plus an additional 25 percent for future growth. Measured loads may be substituted for nameplate loads when the installation and measurement of identical equipment has been established.

2.7.5.3.7. Neutral Conductor Wire Sizing For All Non-Linear Loads.

2.7.5.3.7.1. Feeder neutral conductors for main panels shall be measured at least once a year for a minimum period of four days to ensure neutral currents do not become excessive due to additive harmonic currents. Sub-panel neutral currents shall be measured for a minimum period of 2 days.

2.7.5.3.7.2. In an effort to avoid over-currents on the neutral conductor, the neutral shall be at least the same size as the ungrounded circuit conductors.

2.7.5.4. Molded Case Circuit Breakers

2.7.5.4.1. Selection. The power distribution system shall be provided with molded case circuit breakers sized in accordance with the NEC for their assigned loads. Newly installed breakers shall be rated at 20 amps or larger. These circuit breakers shall be of the same type and manufacturer as those in the power panels. Circuit breakers and load receptacles shall comply with Table 210.21(B)(3) of the NEC. Circuit breakers shall have thermal-magnetic trips.

Exception: Circuit breakers rated at 15 amps are allowed when used to comply with the equipment manufacturer's requirements.

2.7.5.4.2. Circuit Breaker Spares. Provisions shall be made for 25 percent spare breakers or space for breakers for new installations

2.7.5.5. Branch Circuit Receptacles.

2.7.5.5.1. Selection. Branch circuit receptacles shall comply with the NEC for 20 amp or larger circuit breakers.

Exception: Single 15 amps receptacles are allowed when used to comply with the equipment manufacturer's requirements.

2.7.5.6. Circuit Identification.

2.7.5.6.1. Panel Schedule. The panel schedule information shall consist of the room and equipment number (i.e.; 013/008-024) or a brief description of the room and equipment, number of poles, and circuit breaker size.

2.7.5.6.2. Additions/Modifications. Any addition or modification with respect to the loads of a power distribution system shall be legibly documented by the installing agency at the time of the modification. Updates shall be made on a schedule located inside of the panel cover. The information shall consist of the room number in which the equipment is located, the date the schedule was updated, and the equipment number (or brief description of the equipment).

2.7.5.6.3. Wire Labeling. Phase, neutral, and green ground wires within the baseline shall be labeled with the circuit number of the circuit breaker in the power panel from which the wires originate and at the destination terminations. The installing agency is responsible for labeling the conductors.

2.7.5.6.4. TPS Receptacle Marking. All TPS receptacles shall be labeled with the panel and circuit breaker numbers that serve the receptacle. The color of the label shall be orange with black lettering. See **Figure 2.10.** for typical examples of TPS receptacle labels. The installing agency is responsible for labeling the receptacles.

2.7.5.6.4.1. The receptacles are for mission essential equipment only; do not use for vacuums, lights, etc.

2.7.5.6.5. TSPS Receptacle Marking. All TSPS receptacles shall be labeled with the panel and circuit breaker numbers that serve the receptacle. The color of the label shall be yellow with black lettering. See **Figure 2.11.** for typical examples of TSPS receptacle labels. The installing agency is responsible for labeling the receptacles.

Exception: System furniture circuit labeling shall be at base-feed or top-feed junction. Wall mounted convenience receptacles do not require labeling.

2.7.5.6.5.1. The receptacles are for non-mission essential equipment.

2.7.5.6.6. Alternate Receptacle Marking Method. An acceptable alternate method for marking TPS and TSPS receptacles is the use of a label maker that produces a plastic tape, that when printed, resists obliteration. The minimum size of tape shall be ¾ inch and the lettering shall be black, minimum size 3/16 inch. The tape for TPS receptacles shall be orange and for TSPS receptacles it shall be yellow.

2.7.6. Electrical Requirements for System Furniture.

2.7.6.1. New Installations. New system furniture shall have an eight-wire (8-wire) or ten-wire (10-wire), wye configuration electrical system and shall be connected to individual 20 amp branch circuit breakers. The wiring shall consist of a separate neutral conductor for each phase conductor and may share a ground conductor. Refer to the manufacturer's documentation for the exact wire configuration. The minimum wire size shall be #12 AWG in support of a maximum 20-amp circuit breaker. The installation shall also meet the requirements listed below.

2.7.6.1.1. The installation shall not combine technical and non-technical power sources.

2.7.6.2. System Furniture Upgrades or Modifications. System furniture upgrades or modifications shall comply with the requirements of new installations, above. In the event the existing system furniture wiring does not have a separate neutral for each input phase conductor, then one of the following multi-wire circuit configuration upgrades shall be used.

All three input phases shall originate from a single 3-pole circuit breaker and the neutral shall be #10 AWG.

- OR -

The three input phases shall be configured such that the location of the circuit breakers allows a single handle tie to physically connect all three circuit breakers. In

the event one circuit breaker is tripped, all three circuits breakers shall trip. The neutral shall be #10 AWG.

NOTE: The upgrade or modification shall also be limited to six (6) workstations per 3-phase systems furniture group and two (2) personal workstations per input phase.

2.7.7. Verification of New Installations or Major Modifications.

2.7.7.1. Verification. Upon completion of a new installation or major modification, the power and grounding system shall be verified and currents measured on the phase, neutral, equipment safety conductors and/or connections to the Equipotential Ground Plane (EGP). The Configuration Management Office shall perform these verifications.

Figure 2.10. Technical Power Supply Label.

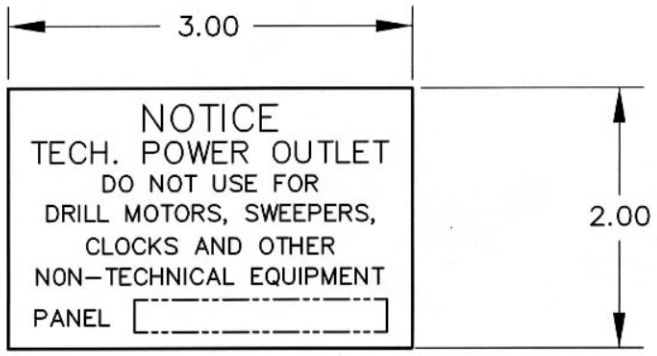
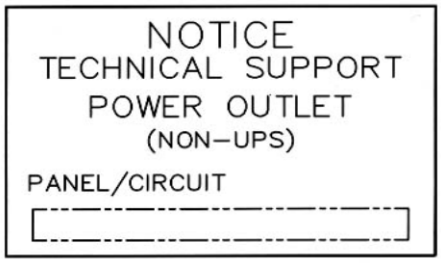


Figure 2.11. Technical Support Power Supply Label.



2.7.7.2. Unused Electrical Circuits Requirement. Unused electrical circuits shall be removed per the requirements of paragraph **2.11.7.**, Removal of Equipment/Facility Preparation.

Section 2H—Grounding Standards.

2.8. General. This section provides SAFB grounding requirements.

2.8.1. Facility Provisions.

2.8.1.1. General Description. Each facility in the SAFB Configuration Baseline has been provided with grounding configurations as described below.

2.8.2. Grounding Design.

2.8.2.1. Conductors. All safety grounding conductors shall be insulated; colored green, green with yellow stripe, or marked green at each end; and sized IAW National Electric Code (NEC) Table 250.122.

Exception: Cable Tray Systems, paragraph **2.8.5.**

2.8.2.2. Connections. Bolting or screws able to maintain 1200-to-1500 psi between contact surfaces, or welding at the termination shall connect the grounding conductor.

2.8.3. Derived AC Systems.

2.8.3.1. Grounded Neutral Conductor Bonding. The neutral of all derived AC systems shall be bonded to ground with an insulated conductor the same size or larger than the largest service or secondary conductor or #4 AWG, whichever is greater. Derived AC systems shall have their neutrals bonded at one point only; at the "XO" of the separately derived source or at the first system disconnect.

2.8.3.2. Isolated Ground Bus. Any isolated ground bus shall be independently connected to ground at the neutral-ground bond of the separately derived system or at the ground bus at the first disconnect of the separately derived system.

2.8.3.3. Green-Wire Bus and Grounding. A safety, green-wire ground bus is provided in each power distribution panel. All power feeders and branch circuits shall be installed with a safety green-wire grounding conductor run with the phase and neutral conductors. The copper safety green-wire grounding conductor shall be sized IAW NEC Table 250.122 and/or MIL-HDBK-419 Table 1-21. Aluminum or copper-clad aluminum wire shall not be used.

2.8.3.4. Filter Grounding. The grounding conductor shall be bonded to the unfiltered and filtered sides of the filter box of a shielded area. Additionally, the grounding conductor on the filtered side shall be bonded to building steel. This configuration applies to all new construction and modifications of existing power cables in shielded areas.

2.8.4. Raised Floor System.

2.8.4.1. Requirement. A raised-floor system is a drop-in or removable grid system and shall not be used or supplemented as a safety, green-wire ground or a signal reference ground.

2.8.5. Communications Cable Tray Systems.

2.8.5.1. Requirement. A bare #2 AWG copper conductor shall be installed throughout each cable tray system and connected with a mechanical clamp to the outside of each cable tray section. The tray system ground conductor shall be bonded to the facility ground.

2.8.6. Specialized Grounding Systems.

2.8.6.1. Requirement. The use of an Equipotential Ground Plane (EGP) has eliminated the need for specialized grounding systems. An EGP eliminates large differences in potential across the ground plane, whereas the use of specialized grounding systems can increase these differences. Specialized grounding systems should be avoided and consideration given to converting specialized systems to an EGP. If conversion to an EGP system is not possible, the specialized system

design must be reviewed by 50 SE for safety, security, and signal ground integrity. Final approval by 50 CES is required before installation.

2.8.7. Grounding Interconnections.

2.8.7.1. Shielded Areas. In shielded areas, all classes of grounding shall be terminated either on the ground plate or on the ground panels. The EGP may be used when the shortest possible grounding conductor length is required or when ultra low noise audio grounding is required.

2.8.7.2. Unshielded Areas. In unshielded areas, separate RED and BLACK grounds are provided for grounding. When an EGP is installed, the RED and BLACK grounding panels/plates shall be electrically connected to each other and to the EGP.

2.8.7.3. Equipotential Grounding Plane (EGP) Applications. Per MIL-HDBK-419, where new grounding systems are to be installed or where the grounding system is to be converted from an existing Single-Earth Ground Point (SEGP) to an EGP, the installing agency must ensure the following:

2.8.7.3.1. The EGP scheme shall satisfy high and low frequency communications/electronics equipment applications.

2.8.7.3.2. The EGP shall comply with MIL-HDBK-419. In the event of a conversion from an existing ground system to an EGP, a ground system noise survey and a ground system differential noise voltage test shall be conducted before and after the technical ground system conversion in accordance with the requirements of MIL-HDBK-419.

NOTE: The Configuration Management Office shall make measurements to ensure the integrity of the grounding systems is maintained after new equipment is installed, or major modifications of equipment that connect to the grounding systems are complete.

Section 2I—Communications Cable Installations.

2.9. General. Unique SAFB communications cable installation standards are outlined in this section.

2.9.1. Fiber Optic and Metallic Cables. This section applies to fiber optic and metallic cables that are used for classified and unclassified data and voice communications and Local Area Networks (LANs) on SAFB. Fiber optic cables with non-conductive characteristics (i.e., non-conductive jackets, strengtheners, etc.) and shielded metallic cables shall be used throughout the SAFB cable distribution system.

2.9.2. SAFB Cable Distribution System. The SAFB cable distribution system encompasses the cable conveyances located within facilities under Site Integration Control, and in the cable chases and cable vaults, in the utilidor between buildings, and the network of duct banks and manholes.

2.9.2.1. Cable Protection. Communications cables shall penetrate a wall in a manner that shall protect the cable from damage and maintain the fire rating of the wall. This may be done by using an insulated, throat-type bushing or similar device.

2.9.2.2. Installation Compliance. Installations shall comply with the NEC article 300.21, AFMAN 33-214 VOL 2, NSTISSAM TEMPEST/2-95, and the Air Force Handbook for EMI/EMC (DH1-4).

2.9.2.3. Communications Cable Distribution. Distribution of RED and BLACK communications cables, including administrative communication cabling, shall be by means of RED and BLACK cable tray, conduit and "D" ring conveyances. When BLACK communications cables must be routed in the ceiling space, installation shall be in metal conduit or wire ways (see **2.9.2.** and **2.9.3.**). Cables may penetrate sidewalls of equipment racks to provide routing between adjacent racks only. Grommets must be used when routing through equipment racks. Cables shall not be run on the surface of raised floors or under carpet tiles.

2.9.2.3.1. "D" Ring Installations. "D" rings may be used only as an extension of cable conveyances for unclassified shielded metallic cables used for administrative communications service (i.e., unclassified telephone service and unclassified administrative LAN service). The following guidelines apply:

2.9.2.3.1.1. "D" rings shall be no longer than six inches and shall be installed at intervals not to exceed four feet.

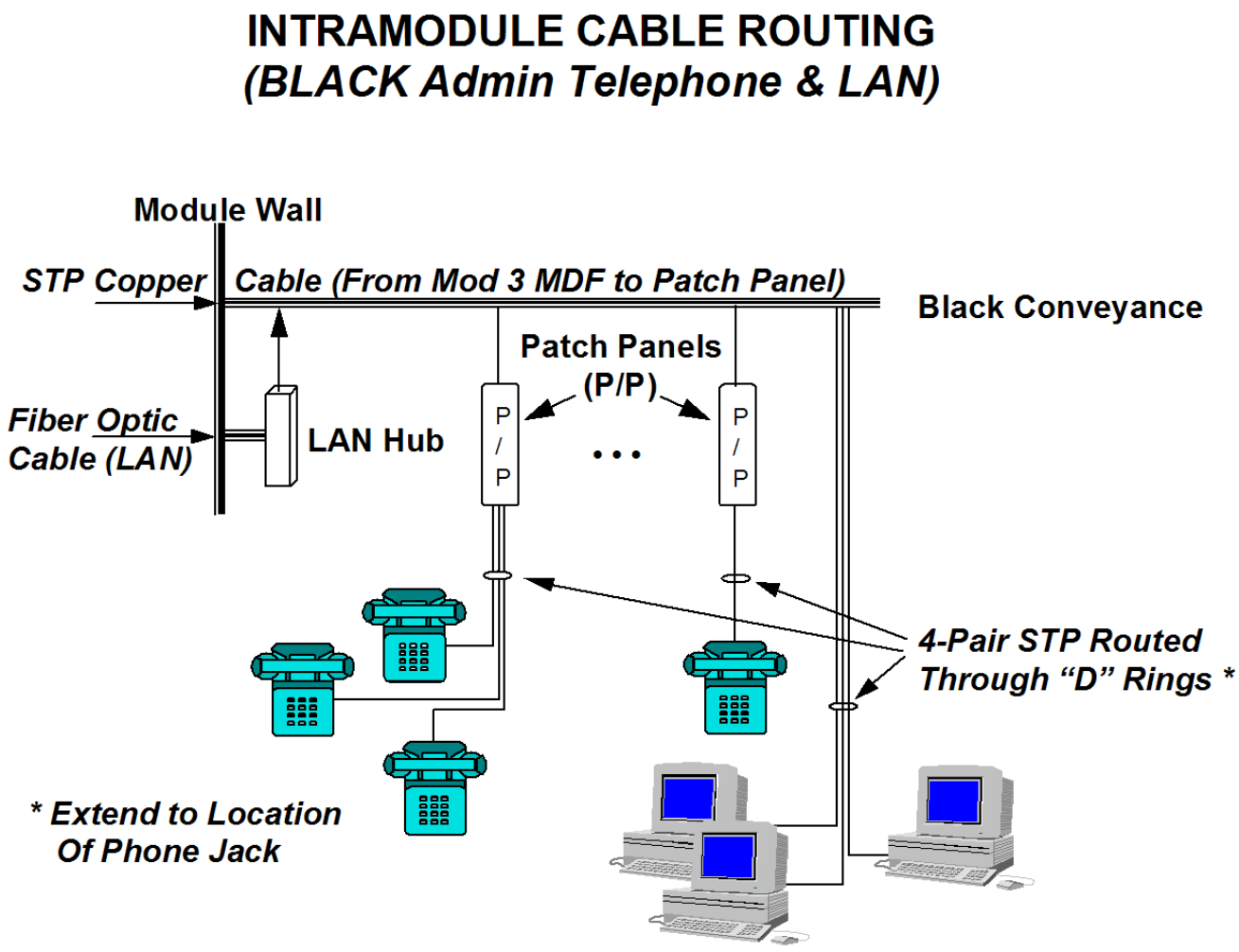
2.9.2.3.1.2. Total cable length supported by "D" rings shall not exceed 40 feet in from conveyance.

2.9.2.3.1.3. "D" rings shall be firmly attached to the under-floor stanchions by using an appropriate fastener such as nylon cable tie wraps or stanchion clamps (wire, tape, or string are not considered appropriate). Trim excess ends flush with retainer. (Reference TO 31-10-13).

2.9.2.3.1.4. "D" rings shall be installed in the lowest underfloor level, but not to touch the floor.

2.9.2.3.1.5. Cable installed through "D" rings shall not be routed diagonally and shall use the minimum number of 90-degree bends. **Figure 2.13.** depicts intra-module cable routing for administrative communications cabling.

Figure 2.12. Intra-module Cable Routing for Administrative Communications (Building 400).



2.9.2.4. Communications Cable Distribution Between SAFB Buildings and Leaving SAFB.

2.9.2.4.1. Cable distribution between SAFB buildings shall be by means of approved conveyances within the base utilidor system and/or the manhole and duct bank system.

2.9.2.4.2. Top Secret/Special Access (TS/SA) cables to be installed between SAFB buildings shall use a simple carrier system.

2.9.2.4.3. Fiber optic cables with non-conductive characteristics shall be used for all communications cables entering or leaving SAFB.

2.9.3. RED/BLACK Separation. Cables shall be installed in the RED, BLACK, and fiber optic-only cable conveyances on SAFB per AFMAN 33-214 VOL 2.

NOTE: Multi-strand fiber optic cables carrying both RED and BLACK signals must have an opaque, non-conductive covering around each strand. Such multi-strand cables must be installed only in RED conveyances or fiber optic-only conveyances.

2.9.3.1. Top Secret/Special Access (TS/SA) Conveyances. All metallic or fiber optic cables carrying clear text TS/SA signals shall be installed in TS/SA conveyances (within a TS/SA controlled area). Exceptions are by written approval only. When these cables exit the TS/SA controlled area, the cables must be installed in an approved simple carrier per AFSSI 3030.

2.9.4. Authorized Cable Types. All communications cables (fiber optic or metallic) and other non-power cables not specifically listed for an application, or as a component part of the computer systems and other equipment to which it is connected, shall meet the requirements described below.

2.9.4.1. Fiber optic cable shall have non-conductive characteristics (i.e., non-conductive jackets, strengtheners, etc.) and be NEC listed. (See **Figure 2.13.**).

2.9.4.2. Metallic cables shall be shielded, NEC listed and shall have the capability to be grounded per MIL-STD-1542B. Metallic cables shall be grounded in accordance with TO 31-10-24.

2.9.4.3. For Administrative Phone or LAN, CAT-5 shall be used when installing copper cable.

2.9.4.4. Cable Installation Standards and Testing. Telecommunication and LAN copper infrastructure shall be installed and tested per this document (SIS) and TIA/EIA-568-A, TIA/EIA TSB-67, Transmission Performance Specification for Testing UTP Cabling Systems. This includes attenuation, NEXT, length, and wiremap in Basic Link and Channel configurations. If the infrastructure shall carry traffic on more than 2 pairs, then Equal-Level, Far-End Crosstalk (ELF-EXT) tests are also required. All fiber optic cables shall be installed and tested per this document and TIA/EIA-526-14A, method B and TIA/EIA-526-7, method A.1 (see **Attachment 3**, section D). All tests shall be at the appropriate wavelengths for the type of fiber (850 and 1310nm for Multimode, 1310 and 1550nm for Singlemode) and at a consistent pulse rate via an Optical Time Domain Reflectometer (OTDR) and Optical Power Meter. All testing documentation shall be delivered to 50 SCS/SCX as part of the project documentation within ten (10) working days of project completion.

2.9.5. Waveguides And Rigid Coaxial Cable.

2.9.5.1. Installation. Waveguide and rigid coaxial cable runs shall be made as short as possible and shall contain a minimum of couplings and bends. Bends shall be accomplished using standard manufactured fittings. Particular care shall be given to the proper alignment and fitting of waveguide sections during installation. Horizontal sections of waveguide and rigid coaxial cable shall be level and vertical sections shall be plumb.

2.9.5.2. Pressurization. Where installation for pressurization is required, fittings shall be sealed and airtight. Bottled nitrogen shall be used for pressurization of waveguide systems and for rigid coaxial cables systems that have normal leak rates of less than 0.0026-cfm. Systems having higher leak rates and/or that require a continuous supply of gaseous dielectric to maintain their electrical characteristics shall be pressurized with dehydrated air. A line bleed assembly shall be installed at the end of each line to permit purging. The assembly shall consist of a 2-1/2 inch diameter pressure gauge and a bleed valve. The pressure gauge shall be installed upstream of the bleed valve.

2.9.6. General Installation Guidelines.

2.9.6.1. Routing in Cable Trays.

2.9.6.1.1. All metallic communications cables shall be installed in separate RED/BLACK cable conveyance devices.

2.9.6.1.2. Cables shall be installed parallel and in an orderly fashion to permit the maximum number to be installed in each section of tray. Where cable transitions are made, cables shall be installed without tension. Cables shall be free from sharp bends and kinks.

2.9.6.1.3. All cables routed in the underfloor space or suspended from ceilings shall be installed in an approved conveyance. The distance from the conveyance to the raised-floor penetration shall not exceed a three-foot horizontal run.

2.9.6.1.4. Cables installed where the raised-floor height is one foot or less may be laid on the sub floor surface provided the surface is free of objects that could damage the cable. Cable trays are not required in these areas; however, RED/BLACK separation shall be maintained.

2.9.6.1.5. While installing cables, the pulling tension of a fiber optic cable shall not exceed the manufacturer's rated maximum tensile loading of the cable being installed. Fiber optic cable shall not be bent beyond the rated minimum bend radius of the cable being installed. A fiber optic service loop shall not exceed five feet on each end.

2.9.6.1.6. TPS/TSPS power cables shall not be installed in the same conveyance device as data and communications cables to include not using the same ceiling, floor or wall penetrations, per MIL-HDBK-232A, 5.3.2. Combination power and communications cables are not authorized.

2.9.6.2. Cable Termination Methods. Cables shall be terminated according to standard installation practices. The following guidelines apply:

2.9.6.2.1. All cables shall be terminated in connectors, terminal boards or barrier strips. Cable conductors shall be fanned out to match the terminals to which they are attached. Spare conductors shall be cut to a length sufficient to reach any contact and laced into the same bundle with the active conductors. Spare coaxial cables shall be terminated with their characteristic impedance on one end and to a bulkhead or equivalent connector on the source electronic rack.

2.9.6.2.2. All cables shall be supported at the termination points to remove connector and cable strain in accordance with TO 31-10-2. Terminal devices shall be the kind that supports the wire at the insulation. Spare conductors in excess of the connector pins in potted connectors shall be cut back. All cable ties used to restrain wire bundles or cables shall have their excess tails cut off and all sharp edges removed.

2.9.6.2.3. Spare conductors that penetrate a shielded enclosure shall be grounded within the enclosure.

2.9.6.2.4. All standard wires that connect to equipment with screw terminals shall be terminated with an insulated terminal lug. Crimp-on terminals shall be installed with a tool approved by the terminal manufacturer.

2.9.6.2.5. Shields and drain wires that are not required to be connected at the equipment shall be cut off close to the cable and taped. The shrink-on ID sleeve may be positioned to insulate the shield end instead of tape, provided the sleeve completely insulates the end of the cable.

2.9.6.2.6. The installing agency shall install terminal boxes as close to the equipment as practical. Boxes shall accept appropriate incoming and outgoing communications and shall have the volume required by the NEC for the number of conductors enclosed. A minimum of 20 percent spare terminal board strips shall be provided in each box.

Figure 2.13. Acceptable Cable Fire Rating Designators for SAFB.

Acceptable Cable Fire Rating Designators

(All listed for GENERAL PURPOSE USE or better)

Cable Type	NEC Article	Rating Designator
Communication Cable	800	MPP, CMP, MPR, CMR, MPG, CMG, CM
Signaling Circuits	725	CL3P, CL2P, CL3R, CL2R, CL3, CL2
Fire Alarm Circuits	760	FPLP, FPLR, FPL
TV and Radio	820	CATVP, CATVR, CATV
Optical Fiber	770	OFNP, OFNR, OFNG, OFN
IT Equipment	645	DP, CL2, CL3, NPLF, FPL, OFN, CM, MP, CATV

* PLENUM or RISER rated cables are preferred for use but not required. NEC Article 645. (Will show up as a suffix on cable rating designated by a "P" or "R").

* ALL cables shall have the UL rating printed on the insulation as proof that the specific cable has passed the tests required by the NEC. Previously installed non-rated cable will be replaced with rated cable when the equipment item is changed or relocated requiring rerouting of the cable outside an equipment rack.

* Under NO conditions shall a cable designator or rating ending in "C" (CONDUCTIVE JACKET) or "X" (RESIDENTIAL) be approved for installation at SAFB.

* Non fire-rated cabling may be used in direct-bury installations only.

2.9.6.3. Tray Fill Considerations. Cable lengths shall be selected to minimize excess cable in the trays and cable wireway. For runs between buildings and building modules service loops for fiber optic cable shall be no greater than five feet at each end. Copper, when installed and fanned correctly, should not need service loops. The maximum cross-sectional area fill rates shall be IAW TO 31-10-13, table 1-3.

2.9.6.3.1. Service loops shall not be put in cable trays or on the floor. Cable shall be coiled into service loop and attached to the side of the cable tray, or support stanchion with a nylon cable tie wrap.

2.9.6.4. Cable Splicing.

2.9.6.4.1. Metallic Cable. Lengths of cable shall be continuous and without splices between termination points. When required, the only cable-to-cable interconnection permitted shall be by connecting cables that have been terminated in either multi-pin or coaxial connectors. Interconnections shall be moisture resistant and continue all electrical and mechanical characteristics of the cable. In-line connectors for both multiconductor and coaxial cables shall be covered with an appropriate insulating sleeve (i.e., heat-shrink tubing). Complete integrity of

the cable shielding shall be maintained. When metallic cables are extended in this manner, the requirements defined in the following sections shall apply.

2.9.6.4.1.1. Insulation of an in-line connector shall be by installation of a section of heat-shrink tubing over the connector. The tubing manufacturer's Installation Specifications shall be used to shrink the tubing down to an even fit over the full connector run. Tubing shall be of the correct size to shrink snugly over the full length of the installation. The tube shall extend at least two inches beyond the connector at each end. Heat-shrink tubing shall comply with MIL-I-7444.

2.9.6.4.2. Fiber Optic Cable. Specific installation procedures for fiber cable splicing shall be fusion type. (Reference TO 31-10-34).

2.9.6.4.2.1. Vendors have varying procedures for fiber cleaving, fiber end preparation and connector-to-fiber mating. Procedures for SAFB shall be per TO 31-10-34 and other applicable TOs. All Equipment-unique installation instructions and procedures shall be submitted to 50 SCS/SCX for evaluation prior to starting installation.

2.9.6.4.2.2. Installation, conveyance, and termination of fiber optic cables shall be done in accordance with TO 31-10-34 to protect individual fiber strands from damage and provide appropriate strain relief.

2.9.7. Cable Marking. Cable labels shall meet size, location and information content as listed in TO 31-10-13, paragraph 1-13.

2.9.7.1. Cable Labeling Requirements. Each cable shall be identified at the time of installation by number and letter combinations using permanently attached markers. Cables shall be marked with the cable designator at both ends, inside manholes and junction boxes, and within 12 inches of entry and exit from multi-cable transits, waveguides, wall penetrations, and enclosures. (See **Figure 2.16.**)

2.9.7.1.1. If interduct flexible conduit is used, cable designators of cables routed through the conduit shall be marked on the outside of the interduct conduit. Cable conveyance enclosures that do not allow visual verification of cables shall have an attached tag that lists the cables contained therein. If the cable is fiber optic, the words "Fiber Optic Cable" shall be labeled next to the cable designator. This requirement shall be waived if the cable has been marked "Fiber Optics" by the manufacturer at the time the cable was built. Where the ends of the cable are not visible or accessible, the labels shall be affixed to the cables down line at the first place where access can be achieved.

2.9.7.1.2. The Start Equipment Reference Designator (SERD) and the End Equipment Reference Designator (EERD) shall be marked at each end of the cables on the same labels as the Cable ID number. Cable markers shall be of non-conductive material. **Figure 2.14.** illustrates the required cable marking.

2.9.7.2. Intra-Rack Equipment. Cables that do not leave a rack are not required to be marked. Marking of such cables is up to the discretion of the installer. If the installer uses a cable management number, it must be documented with I/MAR documentation and entered into the Cable Management Database.

2.9.7.2.1. Cable management will provide cable designators and labels when requested.

2.9.7.2.2. Equipment such as stand-alone desktop computers that have cables to connect components of a system such as mouse, keyboard etc., need not be marked unless the cabling runs through the cable tray system. Cables that provide external connectivity (I.E. LAN cables) shall be labeled appropriately.

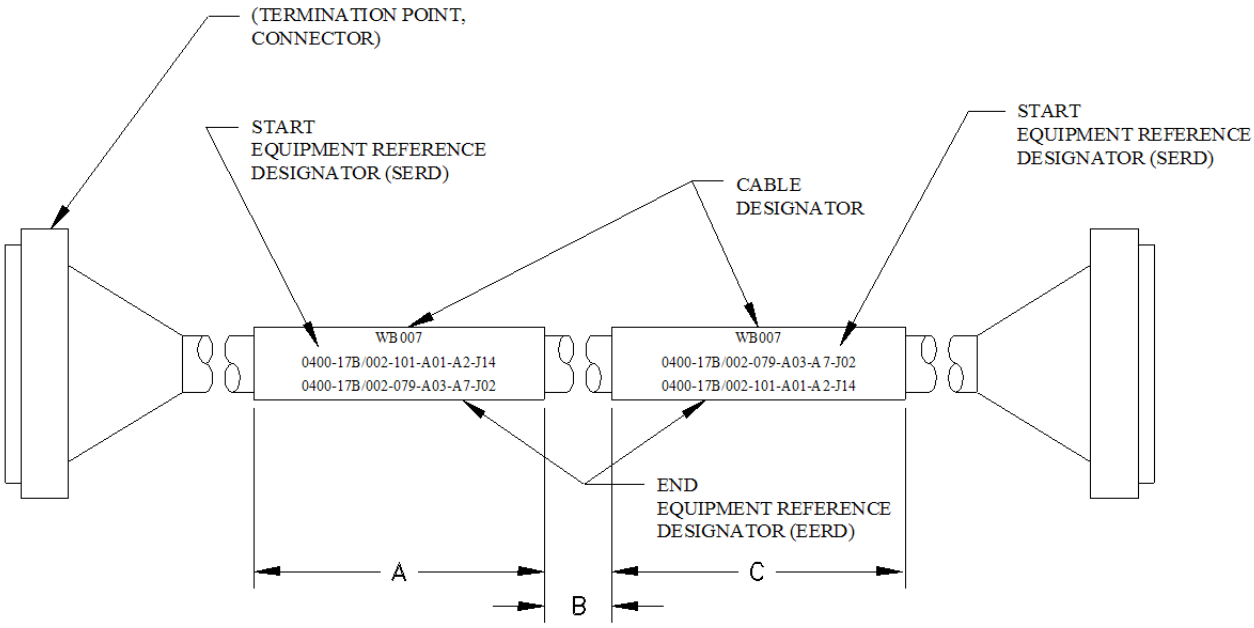
2.9.7.3. Attaching Devices. An identification label shall be attached to each cable by means of non-metallic attaching devices such as polyethylene tubing, nylon label ties, self-laminating adhesive vinyl, silicone rubber sleeving, or synthetic resin sleeving in accordance with MIL-M-60903.

2.9.7.4. Cable Marking Tape. If existing cables are to be re-labeled and shrink tubing cannot be used, the label shall be attached using tape in accordance with MIL-M-60903.

2.9.7.5. ID Tag Marking. Identification tags shall be marked in accordance with MIL-M-60903. Markings shall be of sufficient size and spacing to be legible, and of a color that contrasts with the material on which it is marked. All markings shall be permanent. Any of the following methods may be used:

2.9.7.5.1. Permanent ink stamping.

Figure 2.14. Typical Cable Identification Tag Requirements.



A & C -	Locate label to suit installations, but no more than 12 inches from the connector.
B -	When an additional cable information label is required it must be placed at both ends within 3 inches of the SERD label.

2.9.7.5.2. Paint stenciling.

2.9.7.5.3. Typing/hand-printing (covered with a suitable protective material).

2.9.7.5.4. Hot impression stamping (Kingsley machine or equivalent).

2.9.7.6. Buried Cables. Direct-buried cables shall be marked with the cable designator at each end.

Section 2J—Cable Conveyance Devices.

2.10. General. This section defines specific conveyance device requirements.

2.10.1. RED and BLACK Conveyances. Separate RED and BLACK conveyances have been installed, as required, to provide raceways for fiber optic and metallic communications cables. Between buildings on SAFB, conveyances have been installed in the utilidor and in the underground manhole and duct bank system to distribute BLACK communications cables.

2.10.2. Cable Trays. Cable trays shall be installed in a pattern that provides optimum coverage of the module and minimizes cable lengths. Generally, cable trays shall be installed parallel to air-conditioning ducts to minimize obstruction to the installation of cables. RED communications cable trays shall be separated from BLACK trays as required by AFMAN 33-214 VOL 2. Separate trays dedicated to fiber optic cables may be installed in building 400. The physical separation required between RED and BLACK metallic cables shall not be met by physically separating cable within the same cable tray.

2.10.2.1. Tray Types. Tray types, material, installation and grounding shall be IAW TO 31-10-24 and paragraph **2.8.5.1.** of this publication.

2.10.2.2. Anchoring. Trays shall be rigidly anchored to the facility at intervals not exceeding the manufacturer's recommended specifications for loads of 75 pounds per linear foot or 8 feet, whichever is less, in one of the following methods:

2.10.2.2.1. When installed on the floor, trays shall be bonded to the floor with an approved adhesive or power-actuated devices such as "redheads".

2.10.2.2.2. When the trays are suspended below the raised floor, they shall be rigidly supported to the floor pedestals using an approved unistrut/clamp system.

2.10.2.2.3. When suspended in other locations such as the cable chases, the trays shall be supported via an approved beam clamp, threaded-rod, and unistrut system.

2.10.2.3. Tray Marking. The installer shall mark Cable trays at the time of installation, with a number assigned by Cable Management. Marking shall occur at intersections, corners, and at intervals of 10 feet or less. Trays shall be marked on the top and sides.

2.10.2.3.1. BLACK Communications Cable Trays. Cable trays that are dedicated to BLACK communications cables shall be visibly labeled "UNCLASSIFIED CABLES ONLY" at intervals not to exceed six feet. The cable tray installer shall perform labeling at the time of installation. See **Figure 2.15.** for a typical unclassified cable tray label.

2.10.2.3.2. Fiber Optic Cable Trays. Cable trays that contain or are dedicated to fiber optic cables shall be visibly labeled "CAUTION FIBER OPTIC CABLES" at intervals not to

exceed six feet. Labeling shall be performed at the time of cable tray installation by the installing agency or by the agency adding fiber optic cable(s) to existing trays.

See **Figure 2.16.** for a typical fiber optic tray label.

2.10.3. Conduit. In underfloor areas and above the ceilings, rigid metal conduit or electrical metallic tubing may be used to provide conveyances for metallic and fiber optic communications cables. All RED/BLACK separation requirements shall be observed in the installation of these conduits. To protect cables routed above-floor, flexible metal or non-metal conduit (maximum total length of six feet) may be used to transition from floor penetrations to equipment that is not installed in racks. In the cable chases, utilidor, manhole system, and cable tray system, non-metallic flexible conduit may be used to provide additional protection to cables that transition out of standard cable conveyances, provided it meets fire code. Flexible conduit shall not be installed in cable trays or in a manner that shall obstruct cable tray fill capacity.

2.10.3.1. Rigid Metal and EMT Conduit. Conduit shall be in compliance with **Section 2H**, Grounding Standards. Setscrew type couplings shall not be used. Rigid metal conduit and EMT used as cable conveyances and supported by floor stanchions shall be bonded at one end to the cable tray ground or the facility ground. Installations that are not supported by floor stanchions and that consist of more than one section shall be bonded at both ends to the facility ground.

2.10.3.1.1. Metal Conduit. Metal conduit, installed above modular false ceilings, shall be suspended from building structure members.

2.10.3.2. Flexible Metal Conduit. Flexible metal conduit shall be securely anchored within one foot of each end and at intervals not to exceed 4.5 feet, even if terminated into a fixture or equipment. Vertical installations of flexible metallic conduit inside walls may exceed six feet in length, and the 4.5-foot support requirement does not apply. In no case shall conduit be used as a safety ground. All flexible conduit shall be grounded to facility ground at each end, except where the conduit terminates in a box or equipment that is grounded. When used in potentially damp areas, flexible conduit shall be used with THHN, damp/dry rated ground conductors.

2.10.3.3. Conduit Marking. Conduit that is installed as a cable conveyance rather than for transition protection shall be marked with a number assigned by Cable Management. Marking shall be accomplished at the time of initial installation by the installer. If an installing agency installs a cable in an unmarked conduit, that agency shall mark the conduit with a number obtained from Cable Management. Marking shall occur at each end and at intervals not to exceed 5 feet. Refer to Cable Management for acceptable marking methods.

2.10.3.3.1. Cable Management issues four different types of conduit numbers. Three of the numbers depict the security classification levels of the cables that run through the conduits. The fourth type of number depicts the special type of cable running through the conduit. All conduits are labeled with a five digit alphanumeric number that begins with the letter “R”. The second letter will have an “N” for classified (RED), a “J” for unclassified (Black), an “L” for Top Secret, or an “S” for Fiber Optic Only, which includes both Red and Black fiber cables. The third letter and the following two numbers of the five-digit number are consecutive counting indicators only and have no other significance.

Section 2K—Miscellaneous Installation Requirements.

2.11. General. Miscellaneous installation standards not covered in other sections are defined.

2.11.1. Special Design Considerations. Modifications to areas under site integration configuration management shall comply with NEC Article 645.2.

2.11.2. Safety. Those agencies responsible for the installation of equipment and changes to areas under configuration management shall comply with the industrial safety accident prevention and safety and health programs defined in AFI 91-301 and Occupational Safety and Health Administration (OSHA) Standards, as applicable. These same agencies shall coordinate with the Configuration Management Office in advance whenever dangerous materials are either shipped or hand-carried onto the site. This includes (but is not limited to) materials such as explosive charges, shots for thermite welding, and toxic or flammable gases. All such dangerous materials shall be stored in a designated area and in approved containers. Control of this material shall be the sole responsibility of each agency using the material.

2.11.2.1. Safety Aspects of Fiber Optics. During fiber optics installation activities, personnel shall be protected from levels of optical radiation that may be damaging to the eyes and from direct injury by fibers, particularly to the human eye or skin.

Figure 2.15. Unclassified Cable Tray Label.

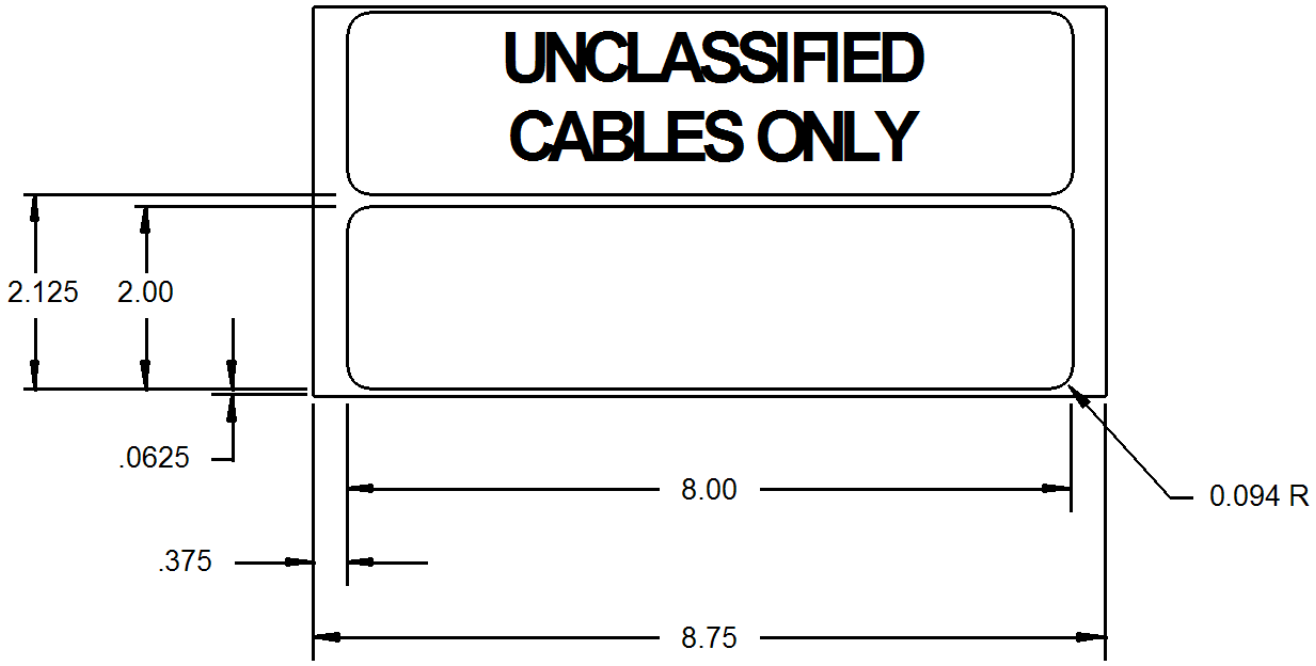
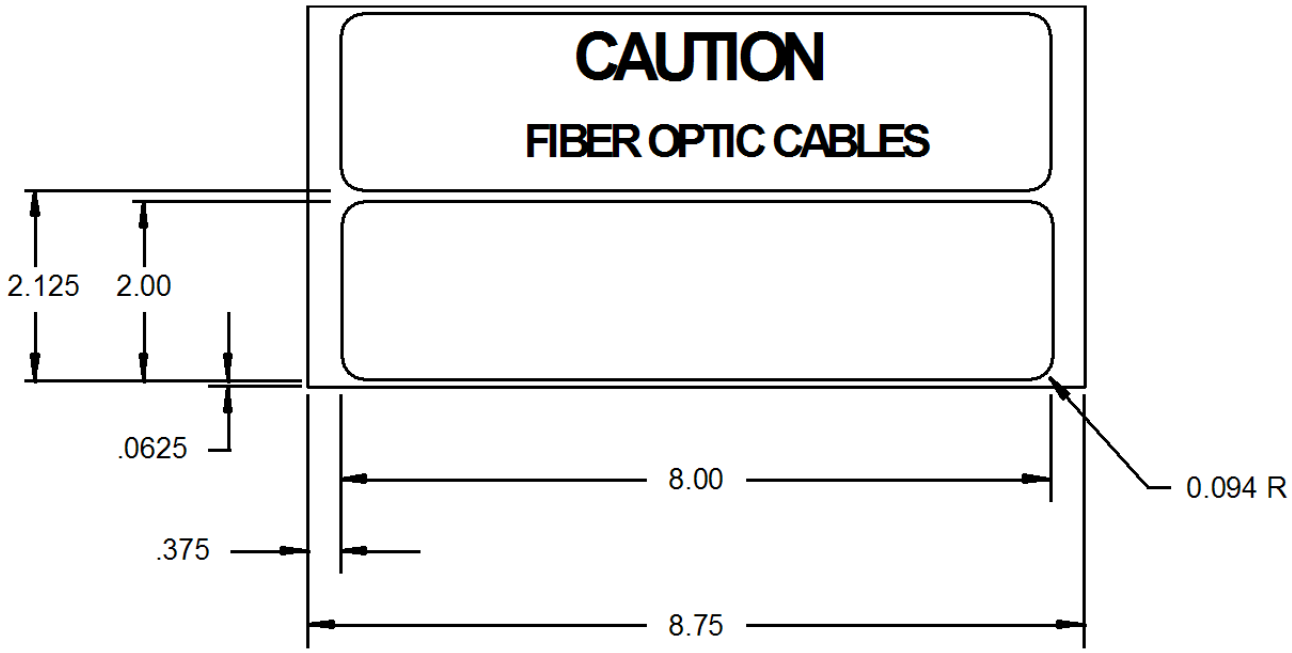


Figure 2.16. Fiber Optic Cable Tray Label (Black on Yellow).



2.11.2.1.1. Optical Radiation. It is possible that the human eye can be damaged by the optical radiation from a fiber at particular power levels. If personnel must work with fibers that are emitting optical radiation, proper eye protection shall be observed. At all terminations and connections along an optical fiber length, a tag or sticker shall be placed as a warning of the presence of potentially harmful optical radiation. All terminations and connectors not in use shall be capped.

2.11.2.1.2. Direct Injury. There is a risk of direct injury to the eye from small lengths or particles of fiber, particularly during cleaving operations. All personnel shall follow prescribed safety measures when cutting fiber optic cables. Protective eye shields shall be worn during cleaving or joining operations. Care shall also be taken to avoid glass fiber penetrating the skin. Due to the strength and small size of glass fiber, skin penetration can occur quite easily. Personnel performing termination or maintenance tasks on fiber optic cables shall clean all work areas.

2.11.2.1.3. Welding, Cutting, Brazing and Open Flame Soldering. Before commencing welding, brazing, cutting or open flame soldering operations, an AF Form 592, USAF Welding, Cutting and Brazing Permit, shall be obtained from the SAFB Fire Department (50 CES/CEFI), located in building 717. Contractors are reminded that welding, cutting and brazing shall be accomplished according to OSHA 1910.252 or 1926.350, as applicable.

2.11.3. Raised Floor Tile Removal and Reinstallation. When accessing the area under a raised floor, take care not to disturb the floor level adjustment. The following guidelines and safety procedures apply to removing raised floor tiles and stringers:

2.11.3.1. Safety Procedures for Raised Floor Openings.

2.11.3.1.1. Remove all carpet squares on the raised floor to be opened. If carpet squares cannot be removed, the carpet squares shall be folded back and taped or clamped so the entire raised floor to be opened is visible.

2.11.3.1.2. An individual must constantly attend the raised-floor opening when possible. If an attendant is not being used, visible barriers or blaze orange traffic cones are to be utilized. Barriers near each corner of the raised-floor opening are recommended. Use of brightly colored safety tape to connect each barrier is also recommended. Barriers must be in place when the raised floor is opened. Carpet shall be replaced to cover the raised floor after closing.

NOTE: A maximum of two floor tiles per module may be removed at any given time when working in an operational module where underfloor air distribution system is required for equipment cooling.

2.11.3.1.3. Paragraphs above do not apply to raised-floor openings during site preparation activities (large Jobs). For site preparation, the entire work area shall be restricted to site preparation workers and individuals requiring entrance for official activities. Workers, surveillance, and visiting personnel, shall be required to receive a safety briefing from the on site supervisor, prior to entry. This briefing shall consist of identification of all hazardous conditions and special precautions being employed.

NOTE: The floor tiles and carpet tiles both have installation arrows on the bottom. These arrows shall point west in the installed position.

2.11.4. Initial Under-floor Site Preparation. (No above-Floor Equipment).

2.11.4.1. Floor Tile and Stringer Removal.

2.11.4.2. Removal of contiguous floor tiles and associated stringers is permitted where no more than one 90-degree bend is formed by an open-floor area.

2.11.4.3. An open-floor area formed by the removal of contiguous floor tiles and associated stringers shall have a maximum width of one floor tile.

2.11.5. Site Preparation Involving Above-Floor Equipment.

2.11.5.1. Floor Tile and Stringer Removal.

2.11.5.1.1. Remove no more than ten contiguous floor tiles. If ten contiguous floor tiles are removed, no stringers may be removed.

2.11.5.1.2. If less than ten contiguous floor tiles are removed one stringer may be removed.

2.11.5.1.3. If no more than three contiguous floor tiles are removed, up to two stringers may be removed.

NOTE: Equipment cooling requirements limit removal of floor tiles in areas where equipment is operating. Replace stringers and floor tiles according to the vendor's installation criteria. Vendor data is available in the Schriever Technical Library (STL).

2.11.6. Testing.

2.11.6.1. Continuity Tests. All wiring on site shall be tested for continuity. Before a system is tested for continuity, all intermediate connections shall be completed. Connections to equipment shall not be made until cable and wiring tests are completed.

2.11.6.2. Continuity Tests. Test Equipment. All test equipment shall use transient-free DC measurement techniques. Continuity testers using buzzers or bells are not permitted. Telephones may be used for communication, but they are not permitted for continuity testing. Optical Power Meters with source shall be used for continuity testing of all fiber strands (see **Attachment 4**, **Section A4C**). Optical Time Domain Reflectometer's (OTDR) may be used for both continuity and power measurements.

2.11.6.3. Cable Defects. Any two- or three-conductor cables with one or more defective wires shall be replaced. For multi-conductor cables consisting of twisted pairs (shielded or unshielded), the defective pair shall be folded back and tied off, and labeled with an appropriate tag. For HEMP considerations, any cable with a defective shield conductor shall be replaced.

2.11.6.4. As-Built Information. After completion of any installation, test, or calibration, installation drawings and wire lists shall be redlined to reflect "as-built" configuration and delivered to the Configuration Management Office within 10-calendar days after the installation date (work complete). Copies of as-built drawings and lists shall be delivered to the appropriate OPR (i.e., 50 SCS/SCX, 50 CES, etc.).

2.11.7. Removal of Equipment/Facility Preparation.

2.11.7.1. General Requirements. Equipment and facility preparation that is no longer required for operations shall not be abandoned in place. Installations that make previous installations obsolete shall remove the unused equipment and facility preparation in its entirety. This requirement is not intended to force the removal of installations that have planned specific uses in the future, but is meant to limit unnecessary congestion in the building. Site preparation left in place for future use shall be tagged at the receptacle end; signal conduit shall be tagged at both ends. Cables will be pulled as far back to the mod access window as possible, coiled up neatly on the floor and tie wrapped. The tag shall be placed at the end of the cable. The tag shall be marked with the following information; Reserved for future growth, date removed, expected re-use date, project name, point of contact, organization and phone number. The door schedule shall be marked "Spare". The

agency requiring the site preparation shall install the tags. The tags will be procured from the Cable Management Office, in bldg. 400, room 208.

2.11.7.2. Receptacle Removal. Unused receptacles below the raised floor (including the wire, conduit, and circuit breaker at the panel) shall be removed. After removal of the circuit breaker, a blank spacer shall be installed in the vacant space and the door schedule shall be updated in accordance with **2.7.5.6.1.** Unused openings in "J" boxes or wireways shall be closed.

2.11.7.3. Cable Removal. When removing equipment, be sure to remove all attached signal cables from the trays and conduits under the raised floor, above the ceilings, or in the walls.

DO NOT ABANDON THESE CABLES—REMOVE THEM COMPLETELY FROM THE PREMISES

2.11.8. Work Site Cleanliness. Equipment shall be protected from damage by debris of any kind, including dust, shavings or grindings from metal, wood, concrete or plastic. Care shall be taken not to allow such materials to enter the underfloor air plenum.

SUZANNE M. VAUTRINOT, Colonel, USAF
Commander, 50th Space Wing

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

Applicable Document Listing.

The following documents form a part of this document to the extent specified herein. In case of conflict between documents, the document with the strictest requirements (as determined by the Configuration Management Office) shall prevail. In the case of document conflicts involving contractors, the Contracting Officer shall provide input for conflict resolution.

Identifier	Title
AFPD 33-1 (Current issue)	Command, Control, Communications, and Computer (C4) Systems
AF TO 31-10 Series (Current Issue)	Air Force Standard Installations Practices
AFI 33-203 (Current Issue)	The Air Force Emissions Security Program
AFI 91-301 (Current Issue)	Air Force Occupational and Environmental Safety
AFSC DH l-4 (Current Issue)	Air Force Design Handbook for EMI/EMC
AFSSI 3030	Protected Distributions Systems
AFSSI 7010 (Current Issue)	The Emission Security Assessment
AFMAN 33-214 VOL 2 (Current Issue)	The Emission Security Counter-Measures Manual
DOD-D-1000B (Current Issue)	Drawings, Engineering and Associated Lists
Federal Specification (Current Issue)	Unions; Bronze or Brass, Thread Pipe Connections, WW-U-516B and Solder-Joint Tube Connections
MIL-C-27072 (Current Issue)	Cable, Special Purpose, Electrical, Multiconductor
MIL-HDBK-411 (Current Issue)	Long Haul Communications (DCS), Power and Environmental Control for Physical Plants

MIL-HDBK-419 .....Grounding, Bonding and Shielding for
(Current Issue) Electronic Equipment and Facilities
MIL-I-631 .....Insulation, Electric, Synthetic Resin
(Current Issue) Composition, Non-Rigid
MIL-I-7444 .....Insulation Sleeving, Electrical, Flexible
(Current Issue)
MIL-I-24391 .....Insulation Tape, Electrical, Plastic, Pressure
(Current Issue) Sensitive
MIL-M-60903 .....Marking of Electrical Wires and Cables
(Current Issue)
MIL-STD-100G .....Engineering Drawing Practices
(Current Issue)
MIL-STD-101B .....Color Code for Pipelines and for Compressed
(Current Issue) Gas Cylinders
MIL-STD-1542B .....Electromagnetic Compatibility and
(Current Issue) Grounding Requirements for Space
System Facilities
MIL-STD-188-114 .....Electrical Characteristics of Digital Interface
(Current Issue) Circuits
MIL-STD-285 .....Attenuation Measurements for Enclosures,
(Current Issue) Electromagnetic Shielding, for Electronic
Test Purposes
NACSEM 5204 .....Shielded Enclosures
(Current Issue)
NSTISSAM TEMPEST/2-95 .....RED/BLACK Installation Guidance
(Current Issue)
SD-CSOC-00034.....Facilities Development Specification for the
(Current Issue) Consolidated Space Operations Center
American Society for Testing and Material (ASTM) Publications
B 32-76 .....Solder Metal
(Current Issue)

B 88-81 .....Seamless Copper Water Tube
(Current Issue)
C635-91 .....Standard Specification for Metal
(Current Issue) Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
C636-91 .....Recommended Practice for Installation of
(Current Issue) Metal Suspension System for Acoustical Tile and Lay-In Panels

American National Standards Institute (ANSI) Publications

B16.18.....Cast Bronze Solder Joint Pressure Fittings
(Current Issue)
B16.22.....Wrought Copper and Bronze Solder Joint
(Current Issue) Pressure Fittings
B31.1.....Power Piping
(Current Issue)
EIA RS-310.....Racks, Panels, and Associated Equipment
Y32.16-1975 .....IEEE Standard Reference Designations for Electrical and Electronics Parts and Equipment
TIA/EIA-568-A.....Commercial Building Telecommunications Wiring Standard.
TIA/EIA TSB-67 .....Performance Specification for Testing UTP Cabling Systems

National Fire Protection Association (NFPA) Standards

NFPA 13 .....Standard for the Installation of Sprinkler
(Current Issue) Systems
NFPA 14.....Installation of Standpipe and Hose Systems
(Current Issue)
NFPA 70.....National Electrical Code
(Current Issue)
NFPA 72.....National Fire Alarm Code
(Current Issue)

NFPA 75 .....Electronic Computer/Data Processing
(Current Issue) Equipment
NFPA 90A .....Installation of Air Conditioning and
(Current Issue) Ventilating Systems
NFPA 101 .....Life Safety Code
(Current Issue)

International Conference of Building Officials

ICBO .....Uniform Mechanical Code
(Current Issue)

Occupational Safety and Health Administration (OSHA) Publications

All current OSHA standards.

References

The following documents are referenced for the convenience of the user of this document. The documents do not form a part of this document and are not made applicable by their reference herein.

50SWI 33-113 Installation / Modification Authorization
(Current Issue) and Scheduling Process (50 SW Form 19)
50 SWI 33-114.....Cable Management
(Current Issue)
MIL-HDBK-1190 .....Facility Planning and Design Guide
(Current Issue)

Abbreviations and Acronyms

AC—Alternating Current

AF—Air Force

AFB—Air Force Base

AFCSC—Air Force Cryptologic Support Center

AFI—Air Force Instruction

AFSSI—Air Force Systems Security Instruction

AFSSM—Air Force Systems Security Manual

AMP—Ampere

ANSI—American National Standards Institute

APO—Air Power Off

ASTM—American Society for Testing and Material

AWG—American Wire Gauge

BCE—Base Civil Engineering

CAT—Category

CES—Civil Engineering Squadron

CF—Compression Fittings

CFM—Cubic feet per Minute

CFR—Code of Federal Regulations

CIBR—Communications Infrastructure Baseline Racks

CP—Conduit Penetration

CRAC—Computer Room Air Conditioner

CS—Communications Squadron

CSOC—Consolidated Space Operations Center

dB—Decibel

DC—Direct Current

DCS—Defense Communications System

DoD—Department of Defense

E&A—Engineering and Administration

EERD—End Equipment Reference Designator

EIA—Electronic Industries Association

EGP—Equipotential Grounding Plane

EMC—Electromagnetic Compatibility

EMI—Electromagnetic Interference

EMSEC—Emissions Security

EMT—Electrical Metallic Tubing

EPO—Emergency Power Off

Ft—Foot/Feet

HDBK—Handbook

HEMP—High Altitude Electromagnetic Pulse

HVAC—Heating Ventilation and Air Conditioning

Hz—Hertz

IAW—In Accordance With

ID—Identification

IEEE—Institute of Electrical and Electronics Engineers

I/MAR—Installation/Modification Authorization Request

IT—Information Technology

Km—Kilometer

LAN—Local Area Network

LMR—Land Mobile Radio

M—Meter

MM—Millimeter

MCB—Modification Control Board

MCT—Multi-Cable Transit

MIL—Military

NACSEM—National Communications Security/Emanation Security Information Memorandum

NEC—National Electrical Code

NEMA—National Electrical Manufactures Association

NEXT—Near-End Cross Talk

NFPA—National Fire Protection Association

NM—Nanometer

OD—Outside Diameter

OPR—Office of Primary Responsibility

OPS—Operations

OSHA—Occupational Safety and Health Administration

OSS—Operations Support Squadron

POC—Point of Contact

PSF —Pounds per Square Foot

PSIG —pounds per square inch gauge

RMS —Root-Mean-Square

RRR—Reservation/Removal Request

SAFB—Schriever Air Force Base

SE—Office symbol for Wing Safety Office

SERD—Start Equipment Reference Designator

SOC—Satellite Operations Complex

STD —Standard

STL—Schriever Technical Library

SW—Space Wing

TAIDS—Technical Area Integration Drawings

TEMPEST—Study of compromising emanations (not an acronym)

TO—Technical Order

TPS—Technical Power System

TSPS—Technical Support Power System (Non-Tech)

UL—Underwriters Laboratories, Inc.

UPS—Uninterruptible Power System

V—Volts

XO—Neutral-Ground bond at an electric transformer or separately derived AC electrical source

Attachment 2

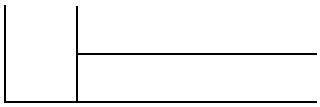
REFERENCE DESIGNATOR SYSTEM

Section A2A—Cable designator.

A2.1. A cable is a bound or sheathed group of individually insulated conductors, either metallic or fiber optic identified with a cable designator. The cable designator is the unique number used to identify a cable connecting between two (and only two) equipment items. All cables shall be identified as outlined below.

A2.1.1. The CABLE DESIGNATOR shall be constructed as follows:

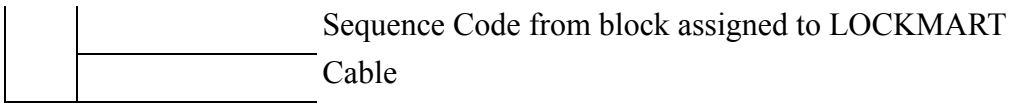
W XnnnnX



A2.1.2. The first character (COMMODITY CODE) of the cable designator is always "W". The second through sixth characters are the SEQUENCE ELEMENT, consisting of a single capital letter followed by four digits to uniquely designate a single cable. A seventh character shall be added, "S" to designate spare. This requirement shall also apply to all conductors in a cable when they are "fanned out" within an assembly, and shall include all spare conductors, which shall be identified by the word "spare" in place of the specific sub-assembly/connector identification.

A2.1.3. The following example illustrates a TYPICAL CABLE DESIGNATOR:

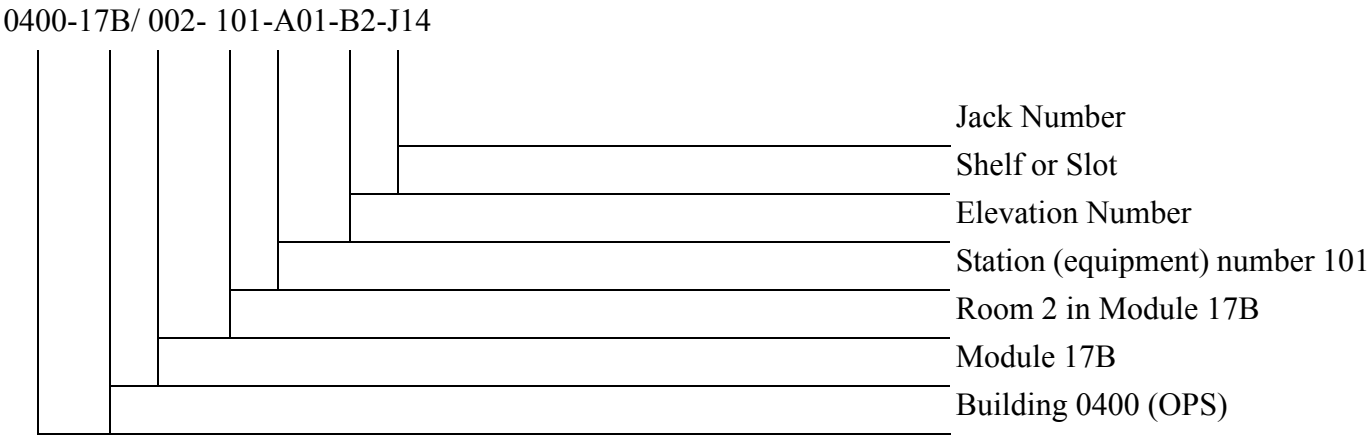
W A7351



Section A2B—Equipment Reference Designator.

A2.2. All equipment identified by **2.5.1.6.** shall be given a unique EQUIPMENT REFERENCE DESIGNATOR consisting of the facility (building) number, module number, room number, and station (equipment) number. This number shall appear, in full, on all installed equipment. The equipment reference designator shall be controlled and issued by Configuration Management Office TAIDS personnel. The Configuration Management Office must approve exceptions.

A2.2.1. The EQUIPMENT REFERENCE DESIGNATOR shall be constructed as follows. Any changes must be coordinated with Configuration Management Office TAIDS and fully documented.



A2.2.2. The Building number is the four-character designator assigned to each facility as recorded on the approved site plan. Presently assigned facility codes are listed in Section D.

A2.2.3. The Module number is the three-character designator assigned to each module on the approved Operations building floor plans. For other facilities with no designated module numbers, these three positions shall contain “000.”

A2.2.4. The Room number is the three-character designator assigned to each room of a facility, as shown on the approved floor plans. Where no room number is assigned within an Operations building module, or where a facility contains only one room, these three positions shall contain “001.”

A2.2.5. The Station (equipment) number is the three-character location designator assigned to each item of equipment in a room or module. The station (equipment) number is taken from existing equipment on the TAIDS drawings. For new installations, equipment numbers shall be obtained per paragraph **A2.2.** The station (equipment) number MUST appear in all equipment reference designations.

A2.2.6. The Elevation number identifies the level in which the equipment is located.

A2.2.7. The Shelf or Slot number identifies the equipment location within the level.

A2.2.8. The Jack number identifies the location on the equipment that the cable plugs into.

Section A2C—Identification Tag Size and Placement.

A2.3. Reference AF TO 31-10-27 for identification tag sizing and placement.

Attachment 3

SAFB FACILITIES UNDER CONFIGURATION MANAGEMENT

FACILITY NUMBER	ROOM/MOD NUMBER	NAME
0120	Comm Room	Gym
0210	108 Comm Room 208 Comm Room 308 Comm Room	Wing Command Building
0300	101 and 153	Engineering & Administration Building
0301	106 Comm Room 206 Comm Room 306 Comm Room	Administration Building
0400	All Modules, Cable Chase, Cable Vault and Roof	Jack Swigert Operations Building
0401	Comm Rooms	
0508	All	LMR
0612	All	DOMSAT Interface Building
0700	All	SATCOM Compound, except Bldg 702
0715	All	850th Communications Squadron Building
3001	Utilidor for	Utilidor, E & A to Main
3005	Communications	Utilidor, Main North
3006	Configuration	Utilidor, CP to Main
3007	Only	Utilidor, South to Main
3008		Utilidor, OPS to Main
6015	All	USNO Satellite Terminal Building
N/A	All	Communications Manholes/Handholes
N/A	Comm Rooms	All new buildings when completed

Attachment 4

COMMUNICATIONS CIRCUIT DESIGN AND INSTALLATION REQUIREMENTS

Section A4A—Introduction.

A4.1. Purpose. This attachment identifies configuration requirements for the design and installation of communications circuits at SAFB. These requirements are established to prevent configuration degradation and ensure uniform operation, maintenance and troubleshooting procedures can be developed for new communications circuits installed. In particular, these standards are intended to ensure that the configurations of new circuit installations are consistent.

A4.1.1. Scope. These requirements apply to contractor and government organizations that design or install new communications circuits on SAFB.

Section A4B—Rack Elevation Standard.

A4.2. Purpose. To establish a Rack Elevation Standard for SAFB.

A4.2.1. Using EIA standard RS-310 and IEEE Standard 200-1975 as references, this rack elevation standard affects all new rack installations and modifications to existing racks.

A4.2.2. Has no other effect on existing racks.

A4.2.3. Rack levels shall be numbered sequentially, beginning with Level A1 at the top of the rack.

A4.2.4. Each level is 1.75 inches in height.

A4.2.5. Equipment is assigned a level based upon the location of its upper edge (see **Figure A4.1.**).

A4.2.6. Rear of equipment racks shall be identified in the same manner except “B” shall be used in place of “A”.

Section A4C—Fiber Optic Cable Testing.

A4.3. ANSI/TIA/EIA 568A.

A4.3.1. Link Segment Performance.

A4.3.1.1. The single performance parameter necessary for performance testing, when installing components compliant with this standard, is link attenuation. Bandwidth (62.5/125 m) and dispersion (single-mode) are important performance parameters, but because they cannot be adversely affected by installation practices, they should be tested by the fiber manufacturer and do not require testing in the field.

A4.3.1.2. The acceptable link attenuation for a 62.5/125 micron horizontal optical fiber cabling system is based on the maximum 90 M (295 ft) distance. The link attenuation equation in H.3.3 is provided to determine “acceptable link performance” for 62.5/125 micron and single-mode backbone-cabling systems. This equation calculates link attenuation for backbone link segments based upon fiber type, cable type, wavelength, link distance and number of splices.

A4.3.1.3. Link attenuation is based on the connectivity requirements of this standard and the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user should follow the procedures established by these standards to accurately conduct performance testing.

A4.3.1.4. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices (i.e., link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers).

A4.3.2. Horizontal Link Measurement.

A4.3.2.1. The horizontal optical fiber cabling link segments need to be tested at only one (1) wavelength. Because of the short length of cabling [90 M (295 ft) or less], attenuation deltas due to wavelength are insignificant. The horizontal link should be tested at 850 nm or 1300 nm in one direction in accordance with ANSI/EIA/TIA-526-14A, Method B, One Reference Jumper. The attenuation test results should be less than 2.0 dB. This value is based on the loss of two (2) connector pairs, one (1) pair at the telecommunications outlet/connector and one (1) pair at the horizontal cross-connect, plus 90 M (295 ft) of optical fiber cable.

NOTE: Link attenuation has been based upon the use of a light source categorized by a Coupled Power Ratio (CPR) of Category 2, Underfilled, per Annex B of ANSI/EIA/TIA-526-14A. The use of a light source categorized as Category 1, Overfilled, may provide results higher than the 2.0 dB. The user is advised to consult ANSI/EIA/TIA-526-14A specifically Annex B and C, for further information concerning the affects of Modal Power Distribution (MPD) and CPR.

A4.3.3. Backbone Link Measurement.

A4.3.3.1. The backbone optical fiber cabling link segment should be tested in one direction at both operating wavelengths to account for attenuation deltas associated with wavelength. Single-mode backbone links should be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper. 62.5/125 micron backbone links should be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A, Method A.1, One Reference Jumper. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation should be used to determine acceptance values based upon this standard's component requirement at each of the applicable wavelengths.

A4.3.4. Link Attenuation Equation and Graphs.

A4.3.4.1. Link attenuation is calculated as:

Link Attenuation = Cable Attn + Connector Attn + Splice Attn

Cable Attn (dB) = Attenuation Coefficient (dB/km) * Length (km)

Attenuation Coefficient:

3.75 dB/km @ 850 nm for 62.5/125 mm

1.5 dB/km @ 1300 nm for 62.5/125 mm

0.5 dB/km @ 1310 nm for single-mode outside plant cable

0.5 dB/km @ 1550 nm for single-mode outside plant cable

1.0 dB/km @ 1310 nm for single-mode inside plant cable

1.0 dB/km @ 1550 nm for single-mode inside plant cable

Connector Attn (dB) = number of connector pairs * connector loss (dB)

= 2 * 0.75 dB = 1.5 dB

Splice Attn (dB) = number of splices (S) * splice loss (dB)

= S * 0.3 dB

A4.3.4.2. Acceptance based on cable type (i.e., outside plant or inside plant), distance, and two connector pairs. The graph does not account for any splice loss. If the link contains splices, add 0.3 dB for each splice in the link. If the link consists of both inside and outside plant cables, then the equation should be used based on the length of each of the cable types.

Power Budget:

Light Source:	Laser
Fiber Type:	SM
Operating Wavelength:	1550 nm
Average Transmitter Output:	-5dB (Includes 10dB Optical Amplifier)
Receiver Sensitivity (10^{-9} BER)	-42dB

System Gain:

Transmitter Average Power	-5 dB
Minus (-) Receiver Sensitivity	-42 dB
System Gain	37 dB

Power Penalties:

Operating Margin	2 dB
Repair Margin 2 Fusion Splices @ .3dB	.6dB
Total	2.6dB

Link Loss Budget:

System Gain	37 dB
Power Penalties	-2.6 dB
Link Loss Budget	34.4dB

Path Calculations:

Connection loss (8 ST @ .7dB per mated pair)	5.6 dB
Splice loss (7 Fusion @ .15 dB)	1.05 dB
OSP cable (102.201 Km. @ .25 dB/Km @ 1550nm) loss	25.55 dB
Path loss	32.2 dB

Information:

Optical Cable

At 850 nm - 3.75 dB per km

At 1300 nm - 1.5 dB per km

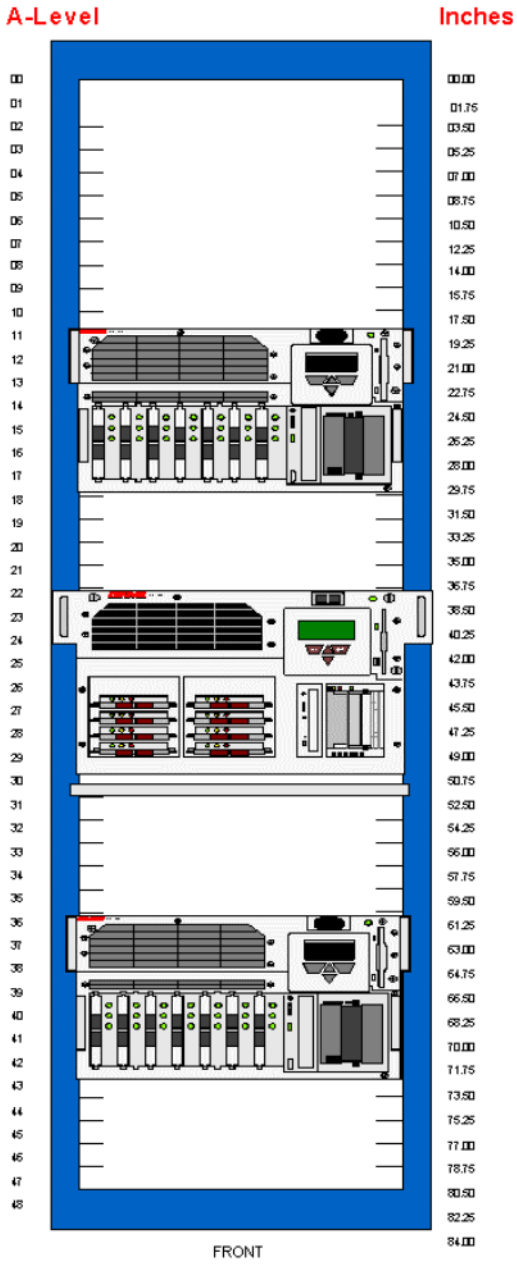
Connectors

Typical loss of between 0.35 and 0.75 dB per connector pair

Splice

Less than 0.5 dB per splice

Figure A4.1. Typical Rack Elevation (Front).



Attachment 5

RACK SPACE MANAGEMENT PROCESS

Section A5A—General.

A5.1. This attachment applies to all contractors and agencies performing work at Schriever Air Force Base (SAFB), regardless of command, and provides information for contractors and agencies planning to utilize rack space resources at SAFB. It applies to Communications Infrastructure Baseline Racks (CIBR). Instructions for submitting the necessary data and interfacing with the Configuration Management Office, 850 SCS/SCYC, and their representatives are provided. Included are references to forms, schedules, and procedures with which all participants must comply.

A5.1.1. This attachment defines the management process for CIBR and shall include, but not be limited to the following:

A5.1.1.1. New rack installations

A5.1.1.2. Rack removals

A5.1.1.3. Installation of new equipment within existing racks

A5.1.1.4. One-for-one upgrades to existing CIBR equipment

A5.1.1.5. Removal of equipment from existing racks

A5.1.1.6. Communication port utilization

A5.2. It establishes policies and procedures for ensuring the proper configuration management of CIBR space at SAFB.

A5.2.1. Before any contractors or agencies on SAFB are granted permission to modify equipment within the CIBR, they must have approval of the following:

A5.2.1.1. Reservation/Removal Request Form (RRR), refer to 50 SWI 33-113.

A5.2.1.2. Installation/Modification Authorization Request (I/MAR – Form 19), refer to 50 SWI 33-113.

A5.3. It is the responsibility of 850 SCS/SCYC to ensure that all participants comply with the procedures specified in this attachment. If a specific circumstance dictates a need for deviation from the set procedures, 850 SCS/SCYC approval must be obtained prior to implementation.

Section A5B—Responsibilities

A5.4. Control of the Rack Space Management System is the responsibility of 850 SCS/SCYC, administered through the Rack Space Management work center.

A5.4.1. The SAFB Scheduling Office receives activity requests involving modification of the CIBR, (including real-time requests) and ensures they are posted to the SAFB schedule.

A5.4.2. Contractors and agencies authorized modification of CIBR are responsible for becoming familiar with these procedures and complying with the applicable SWIs and policies.

Section A5C—Procedures

A5.5. The following procedure shall be adhered to for modifying rack space in an existing CIBR, or adding a new CIBR within SAFB.

A5.5.1. The customer, organization or agency that needs to modify space in a CIBR shall provide the requirement (CSRD, PSA, ECP, etc.) to the 50 SCS Plans and Policy Flight Office, 50 SCS/SCX.

A5.5.2. The customer, 50 SCS/SCX and the Configuration Management Office, 850 SCS/SCYC shall perform a joint site survey.

A5.5.3. 50 SCS/SCX prepares and forwards a Reservation/Removal Request (RRR) to the I/MAR Help Desk.

A5.5.4. I/MAR Help Desk assigns a tracking number to the RRR and forwards the RRR to the Technical Area Integration Drawing (TAID) work center.

A5.5.5. TAID work center assigns new rack numbers and reserves floor space, as required. The RRR is forwarded to the Rack Space Management work center. Should a conflict be identified regarding the floor space requested, the conflict shall be noted on the RRR.

A5.5.6. Rack Space Management reserves space in the requested rack and forwards the RRR to the Power Management work center. Should a conflict be identified regarding the equipment to be added versus the available space, the conflict shall be noted on the RRR.

A5.5.7. Power Management updates the power circuit loading per the information provided in the RRR. Should a conflict be identified regarding the equipment loads to be added versus the existing loads, the conflict shall be noted on the RRR.

A5.5.8. The RRR is submitted to 850 SCS/SCYC for approval.

A5.5.9. Upon approval, the RRR is returned to the I/MAR Help Desk to obtain the module manager's coordination.

A5.5.10. If disapproved, the RRR is returned to 50 SCS/SCX for resolution with the customer.

A5.5.11. The I/MAR Help Desk returns the completed RRR to 50 SCS/SCX.