

# UNIFIED FACILITIES CRITERIA (UFC)

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## TELECOMMUNICATIONS BUILDING CABLING SYSTEMS PLANNING AND DESIGN



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**UNIFIED FACILITIES CRITERIA (UFC)**  
**TELECOMMUNICATIONS**  
**BUILDING CABLING SYSTEM**  
**PLANNING, DESIGN, AND ESTIMATING**

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U.S. ARMY CORPS OF ENGINEERS (Preparing Activity)

NAVAL FACILITIES ENGINEERING COMMAND

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes indicated by \1\ ... /1/)

<b>Change No.</b>	<b>Date</b>	<b>Location</b>

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This UFC supersedes MIL-HDBK-1012/3, dated MAY 1996.

**FOREWORD**

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with [USD\(AT&L\) Memorandum](#) dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

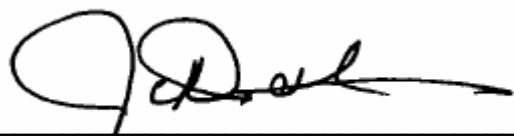
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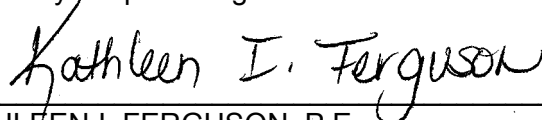
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AUTHORIZED BY:




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JAMES C. DALTON, P.E.  
Chief, Engineering and Construction  
U.S. Army Corps of Engineers



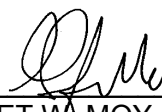

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KATHLEEN I. FERGUSON, P.E.  
The Deputy Civil Engineer  
DCS/Installations & Logistics  
Department of the Air Force




---

STEVEN R. ISELIN, P.E.  
Chief Engineer  
Naval Facilities Engineering Command




---

Dr. GET W. MOY, P.E.  
Director, Installations Requirements and  
Management  
Office of the Deputy Under Secretary of Defense  
(Installations and Environment)

**UNIFIED FACILITIES CRITERIA (UFC)**  
**NEW DOCUMENT SUMMARY SHEET**

**Subject:** UFC-3-580-01 Telecommunications, Building Cabling System

**Cancel:**

**Description:** This UFC (Unified Facilities Criteria) document provides guidance on how to design and implement building telecommunications cabling systems for military construction. An acceptable building cabling system encompasses, but is not limited to, copper and fiber optic (FO) entrance cable, termination equipment, copper and fiber backbone cable, copper and fiber horizontal distribution cable, workstation outlets, racks, cable management, patch panels, cable tray, cable ladder, conduits, grounding, and labeling.

**Reasons for Development:** This UFC is designed to satisfy Army Installation Information Infrastructure Architecture (I3A) policy, UFC 3-580-10 Design: Navy and Marine Corps Intranet (NMCI) Standard Construction Practices Information System (IS), and Engineering Technical Letter (ETL) 02-12: Communications and Information System Criteria for Air Force Facilities requirements within a facility.

The design of building telecommunications cabling systems is a specialized technical area that does not fall in the normal skill record and resume of commanders, architects, engineers and project managers. This UFC provides guidance to those parties tasked with implementing existing and emerging building telecommunications cabling system requirements.

**Impact:** The following direct benefits will result from the publication of UFC-3-580-01:

- Creation of a single source reference for the design and construction of building telecommunications cabling systems
- Reduced facility project costs and efficiencies achieved by a better-educated Command, designer, and project management staff for the specialized technical area of building telecommunications cabling systems.

CHAPTER 1	TELECOMMUNICATIONS BUILDING CABLING SYSTEM.....	1
1-1	OVERVIEW .....	1
1-2	References .....	1
1-3	ACRONYMS AND ABBREVIATIONS .....	1
1-4	Responsibilities .....	3
1-5	Scope .....	3
1-6	Objective .....	3
CHAPTER 2	BUILDING TELECOMMUNICATIONS CABLING SYSTEM	
SPECIFICATIONS	.....	4
2-1	Classified Information Infrastructure .....	4
2-2	System Overview .....	5
2-3	Workstation Outlet.....	5
2-3.1	Outlet Box.....	5
2-3.2	Outlet Faceplate .....	5
2-3.3	Outlet Connectors .....	5
2-3.3.1	Copper Outlet/connector .....	5
2-3.3.2	Fiber Optic Outlet/connector.....	6
2-3.3.3	Coaxial Outlet/connector .....	6
2-3.4	Outlet/Connector Markings.....	6
2-3.5	Outlet Types and Density .....	6
2-3.5.1	Family Housing Units .....	8
2-3.5.1.1	Army Family Housing .....	8
2-3.5.1.2	Navy Family Housing .....	8
2-3.5.1.3	Air Force Family Housing .....	8
2-3.5.1.4	Barracks/Bachelor Quarters .....	8
2-3.5.2	Systems Furniture Wiring .....	9
2-3.6	Utility Rooms and Closets .....	9
2-3.7	Elevators .....	9
2-3.8	Safety, Courtesy, & Convenience.....	9
2-3.9	Building Automation Systems.....	9
2-4	Building Telecommunications Wiring.....	9
2-4.1	Horizontal Cable.....	10
2-4.1.1	Copper Voice and Data .....	10
2-4.1.1.1	Copper Termination.....	10
2-4.1.1.2	Copper Patch Cables .....	10
2-4.1.2	Fiber Optic Cable .....	10
2-4.1.2.1	Fiber Optic Termination.....	11
2-4.1.2.2	Fiber Optic Patch Cables.....	11
2-4.1.3	Cable Length .....	11
2-4.2	Backbone Cable .....	11
2-4.2.1	Copper Backbone Cable .....	11
2-4.2.2	Copper Termination.....	12
2-4.2.3	Fiber Optic Backbone Cable.....	12
2-4.2.3.1	Fiber Optic Termination.....	13
2-4.3	CATV or CCTV Cable .....	13
2-4.3.1	Community Antenna Television (CATV) Systems .....	13

2-4.4	Building Infrastructure .....	14
2-4.4.1	Cable Tray .....	14
2-4.4.2	Enclosed Duct (Raceway) .....	14
2-4.4.3	Conduit .....	14
2-4.4.4	Pull Boxes .....	15
2-4.4.5	Open Office Wiring .....	15
2-4.4.5.1	Systems Furniture Wiring .....	15
2-4.4.5.2	Multi-User Telecommunication Outlet Assembly (MUTOA).....	15
2-4.4.5.3	Consolidation Point (CP) .....	15
2-4.4.5.4	Direct Connection .....	15
2-4.4.5.5	Protection and Separation .....	15
2-4.4.6	Optional Customer Premise Items.....	16
2-5	Telecommunications Room .....	16
2-5.1	Multi-Story Buildings.....	16
2-5.2	Telecommunications Room Sizing .....	16
2-5.3	Room Interior Finishes .....	17
2-5.4	Room Door .....	17
2-5.5	Room Location .....	17
2-5.6	Telephone Backboards .....	17
2-5.7	Equipment Racks .....	17
2-5.8	Equipment Cabinets .....	18
2-5.9	Unshielded Twisted Pair Patch Panels.....	18
2-5.10	Fiber Optic Patch Panels.....	18
2-5.11	Ladder and Wire Cable Tray .....	18
2-5.12	Room Lighting .....	19
2-5.13	Room Climate Control .....	19
2-5.14	Room Contaminants.....	19
2-5.15	Electrical Power.....	19
2-5.16	Voice Communications.....	19
2-6	Equipment Room.....	19
2-6.1	Equipment Room Provisioning .....	19
2-6.1.1	Power Requirements .....	19
2-7	Grounding.....	20
2-7.1	Building Earth Electrode Subsystem (EES).....	20
2-7.2	Cable Entrance Grounding .....	20
2-7.2.1	Building Point of Entrance .....	20
2-7.2.2	Copper Cable Entrance .....	21
2-7.2.3	Fiber Cable Entrance .....	21
2-7.2.4	Copper Protector Block .....	21
2-7.3	Telecommunications Room Signal Ground .....	21
2-7.4	Telecommunications Rack and Supporting Structure.....	22
2-8	Telecommunications System Labeling .....	22
2-8.1	Outlet/Patch Panel Labels .....	22
2-8.2	Conformance to Existing Standards .....	22
2-8.3	Telecommunications Outlet Labeling .....	22
2-8.4	Telecommunications Patch Panel Labeling.....	23
2-8.5	Distribution System Labeling .....	23

2-9	Building Entrance Facility .....	23
2-9.1.1	The Telecommunications Entrance Facility (TEF).....	23
2-9.2	Protected Entrance Terminals (PET).....	23
2-9.2.1	Protector Modules .....	23
2-9.2.2	Sheath Limitations.....	23
2-9.2.3	Stencils.....	23
2-9.3	Fiber Termination Device .....	23
2-10	Testing.....	24
2-10.1	Unshielded Twisted Pair Tests .....	24
2-10.2	Category 5e and 6 Circuits .....	24
2-10.3	Coaxial Cable .....	24
2-10.4	Fiber Optic Cable .....	24
APPENDIX A REFERENCES .....		1
APPENDIX B FIGURES.....		1

## FIGURES

Figure 1	TELECOMMUNICATIONS ROOM ENTRANCE AND BACKBONE DIAGRAM	2
Figure 2	TELECOMMUNICATIONS ROOM HORIZONTAL DISTRIBUTION DIAGRAM .....	3
Figure 3	TELECOMMUNICATIONS ROOM STANDARD SUPPORTING STRUCTURE AND BACKBONE.....	4
Figure 4	TELECOMMUNICATIONS ROOM STANDARD PREMISE DISTRIBUTION...	5
Figure 5	TELECOMMUNICATIONS ROOM HIGH DENSITY PREMISE DISTRIBUTION .....	6
Figure 6	TELECOMMUNICATIONS OUTLET TYPES .....	7
Figure 7	SYSTEMS FURNITURE WIRING .....	8
Figure 8	PREMISE DISTRIBUTION SUPPORTING STRUCTURE - RENOVATION ...	9
Figure 9	TYPICAL FLOOR PLAN.....	10
Figure 10	J-STD-607A GROUNDING .....	11
Figure 11	MIL-STD-188-124B GROUND .....	12

## TABLES

Table 2-1	Outlet Types.....	7
Table 2-2	Coaxial Cable.....	13

**CHAPTER 1 TELECOMMUNICATIONS BUILDING CABLING SYSTEM****1-1 OVERVIEW**

This UFC is intended to provide a telecommunications manager with a means for designing new Building Cabling Systems (BCS) or additions to existing BCS. Sufficient reference material is provided to allow for a basic understanding of a BCS and the components. The provisioning of telecommunications support for MILCON projects is outlined in MIL-HDBK-1190. This guide is intended to address only the requirements for BCS telecommunications pathways and cabling necessary to support voice, data and video systems required for new and renovated facilities. This UFC will establish an implementation concept that can be used to shape architectural templates and influence the design process for Installation Information Infrastructure Architecture (I3A). It will identify proven infrastructure construction techniques, define common practices, and serve as an authoritative implementation guide.

This UFC is consistent with Department of Defense (DoD) Policy Memorandum of June 29, 1994, regarding the use of commercial standards in lieu of military specifications. Unless otherwise specified by the major claimant, or where deemed inadequate for safety reasons, or inappropriate because of the function of the facility, commercial standards must be employed in the planning, design and installation of inside cable plant in support of U.S. Army U.S. Navy and U.S. Air Force sponsored military construction and refurbishment projects. A partial listing of Commercial, Federal and DoD standards, that addresses telecommunications design and installation practices, are provided in Appendix A. The major claimant and the BCS Engineer must jointly review this list to confirm the adequacy of the commercial standards to meet the telecommunications requirements of the particular facility.

**1-2 REFERENCES**

The documents listed in Appendix A are not necessarily all of the documents referenced herein, but are the ones that are needed in order to fully understand the information provided by this handbook. Unless otherwise specified, the issues of the documents cited herein are those listed in the latest issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplements thereto.

**1-3 ACRONYMS AND ABBREVIATIONS**

ADN	Area Distribution Node
AFCESA	Air Force Civil Engineering Support Agency
AFH	Army Family Housing
ANSI	American National Standards Institute
AWG	American Wire Gauge
BCS	Building Cabling Systems
BICSI	Building Industry Consulting Service, International, Inc.
CATV	Cable Television
CCB	Construction Criteria Base
CCTV	Closed Circuit Television

CP	Consolidation Point
CTTA	Certified TEMPEST Technical Authority
DAA	Designated Accreditation Authority
dBmV	Decibel (reference to millivolt)
DC	Direct Current
DCO	Dial Central Office
DDC	Direct Digital Controller
DOIM	Directorate of Information Management
DPW	Directorate of Public Works
DoD	Department of Defense
DODISS	Department of Defense Index of Specifications and Standards
EES	Earth Electrode Subsystem
EIA	Electronics Industry Alliance
EMT	Electrical Metallic Tubing
EUB	End User Building
FOCIS	Fiber Optic Connector Intermateability Standard
FOUO	For Official Use Only
GE	Grounding Equalizer
GHz	Gigahertz
HVAC	Heating, Ventilation and Air Conditioning
I3A	Installation Information Infrastructure Architecture
IMA	Information Mission Area
IS	Information System
LAN	Local Area Network
MHz	Megahertz
MILCON	Military Construction
MRI	Magnetic Resonance Imaging
MUTOA	Multi-User Telecommunication Outlet Assembly
NAVFAC	Naval Facilities Engineering Command
NEC	National Electrical Code
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association, Inc.
NMCI	Navy and Marine Corps Intranet
NSI	National Security Information
OSP	Outside Plant
PDS	Protected Distribution System
PET	Protected Entrance Terminal
RCDD	Registered Communications Distribution Designer
RUS	Rural Utilities Service
TBB	Telecommunications Bonding Backbone
TC	Telecommunications Closet
TEF	Telecommunications Entrance Facility
TGB	Telecommunications Grounding Busbar
TIA	Telecommunications Industry Association
TMGB	Telecommunications Main Grounding Busbar
TR	Telecommunications Room
UFC	Unified Facilities Criteria

UL Underwriters Laboratory, Inc.  
USACE United States Army Corps of Engineers  
UTP Unshielded Twisted Pair

#### 1-4 **RESPONSIBILITIES**

The agency responsible for construction of facilities within the Department of Defense (DOD) is the United States Army Corps of Engineers, the Naval Facilities Engineering Command (NAVFAC), or the Air Force Civil Engineer Support Agency (AFCEA), as assigned within the respective geographic areas by the Office of the Secretary of Defense. DOD directives 5136.10 and 6015.16 provide additional information on responsibilities. The provisioning of telecommunications support for Military Construction (MILCON) projects is outlined in MIL-HDBK-1190. UFC-3-580-01 is intended to address only the requirements for telecommunications pathways and cabling necessary to support voice, data and video systems housed in new facilities. Other system's cabling requirements, such as security, fire alarms and environmental monitoring are not addressed here. In general the construction agency is responsible for providing inside and outside cabling and support structures (pathways) necessary to provide a complete and usable telecommunications distribution system.

#### 1-5 **SCOPE**

This UFC is intended to support the necessary requirements gathering, site surveys, analysis, design and implementation of Information Technology. This guide specifically assists the designer in the integration of the building cabling system. Note: Each service handles telecommunications and information technology funding in different ways. This UFC does not address the funding responsibilities and procedures for military construction projects. Refer to the specific services construction program guidance for funding issues.

#### 1-6 **OBJECTIVE**

The objective of this UFC is to provide planning guidance for the development of an input to the building cabling system telecommunications portion of the DD 1391. This baseline figure is a composite of the costs projected to design, furnish and install requisite BCS cabling systems to support the anticipated user population over the expected life cycles of both the voice and data systems and backbone cabling and pathways designed to support upgrades in the BCS for the life of the structure. Base telecommunications support is predicated on the availability of the existing telephone, data and distribution systems to provide the necessary connectivity and system access to the increased user population.

## CHAPTER 2 BUILDING TELECOMMUNICATIONS CABLING SYSTEM SPECIFICATIONS

The BCS is designed to satisfy Army Installation Information Infrastructure Architecture (I3A) policy, UFC 3-580-10 Design: Navy and Marine Corps Intranet (NMCI) Standard Construction Practices Information System (IS), and Engineering Technical Letter (ETL) 02-12: Communications and Information System Criteria for Air Force Facilities requirements within a facility. The BCS must be installed in accordance with the Telecommunications Industry Association (TIA) and Electronics Industry Alliance (EIA) Building Telecommunications Wiring Standards general guidelines with modifications and clarifications provided below. TIA/EIA specifications can be purchased at <http://www.tiaonline.org/standards/>. Telecommunications design must be performed and stamped by a Registered Communications Distribution Designer (RCDD) for all projects. For projects that involve the Navy Marine Corp Intranet (NMCI), coordinate infrastructure design with UFC 3-580-10 Design: Navy and Marine Corps Intranet (NMCI) Standard Construction Practices. For projects that involve the US Air Force coordinate infrastructure design with ETL 02-12.

### 2-1 CLASSIFIED INFORMATION INFRASTRUCTURE

Engineers engaged in the design of classified (collateral or higher) Information Infrastructure must coordinate the infrastructure design with the Certified TEMPEST Technical Authority (CTTA) and Designated Accreditation Authority (DAA) responsible for that area. This Technical Guide cannot attempt to replace the publications that have been produced to support the design of Red/Black infrastructure. The engineer must consult the following applicable documents for consideration and design guidance: NSTISSAM TEMPEST/2-95 (FOUO) defines the guidance to consider during design and installation, and provides potential solutions, DCID 6/1 and 6/9 (U) define the physical security requirements in construction of secure facilities, NSTISSP 300 (U) provides the National Policy on the Control of Compromising Emanations, and NSTISSI 7003 (U) provides guidance on Protected Distribution Systems. NSTISSAM TEMPEST/2-95 states that the National Policy on the Control of Compromising Emanations (NSTISSP 300) and its implementing instructions, TEMPEST Countermeasures for Facilities (NSTISSI 7000), and NONSTOP Countermeasures (NSTISSI 7001) establish the policy that certain systems and facilities that process national security information (NSI) must be reviewed by a CTTA, and AI PUB-5239-22 Information Assurance Protective Distribution System (PDS) Publication FOUO for Navy projects. If a CTTA review is required, and the review determines that TEMPEST countermeasures are required, the CTTA will consider a variety of methods that can be applied to the system/facility to achieve TEMPEST security. The RED/BLACK guidance contained in NSTISSAM TEMPEST/2-95 (FOUO) will be considered by the CTTA along with other measures (e.g., TEMPEST Zoning, TEMPEST suppressed equipment and shielding) to determine the most cost-effective countermeasures to achieve TEMPEST security. Only those RED/BLACK criteria specifically identified by the CTTA will be implemented. Additional information on grounding can be found in MIL-STD-188-124B and MIL-HNBK-419-A. Information on Protected Distribution Systems can be found in NSTISSI No.7003, 13 December 1996.

## 2-2 SYSTEM OVERVIEW

An acceptable building cabling system encompasses: copper and fiber optic entrance cable, termination equipment, copper and fiber backbone cable, copper and fiber horizontal distribution cable, workstation outlets, racks, cable management, patch panels, cable tray, cable ladder, grounding, and labeling. Figure 1, of Appendix B, provides an overview of the cable entrance and backbone distribution. Figure 2, of Appendix B, provides an overview of the horizontal distribution.

## 2-3 WORKSTATION OUTLET

The following specifications pertain to telecommunications outlets and connectors:

### 2-3.1 Outlet Box

Specify double gang electrical boxes of at least 2-1/8" (54 mm) depth to provide dedicated space for current and possible future fiber optic cable installation. For single connector outlets, such as voice-only, cable television (CATV) or closed circuit television (CCTV), use a single gang 2" by 4" by 2-1/4" (51 mm x 102 mm x 57 mm), electrical box recess mounted, with the faceplate flush with the wall surface. Locate a service power outlet within 6 inches (152 mm) of all outlets. The power outlet circuits must be based on a loading assumption that each location of two duplex receptacles will power one personal computer with a monitor along with typical office appurtenances such as task lights; also assume that there will be no diversification of this load. For Navy projects, utilize 4-inch (102 mm) square by 2-1/4 inch (57 mm) deep boxes for single gang, four outlet copper telecommunications configurations that do not have provision for fiber optic cabling. For Army projects, specify 4-11/16-inch (119 mm) square by 2-1/4 (57 mm) boxes for 1-inch (27 mm) conduit installations and outlet boxes that have or may require fiber optic cabling.

### 2-3.2 Outlet Faceplate

Use a full (double gang) faceplate for standard administrative outlet locations, with connectors for all copper and (if used) fiber optic cable. Standard administrative outlets may, by specific user request, use single gang outlet faceplates in conjunction with a reducing ring. For single gang outlet boxes, use a single gang outlet faceplate with appropriate connector locations and, if required, mounting lugs for wall phones. Outlet faceplate must include two blanks position for future applications.

### 2-3.3 Outlet Connectors

The following specifications pertain to copper, fiber optic and coaxial cable outlet/connector. The category for cable, jacks, termination blocks, and patch panels must be the same throughout each circuit and system. Specify more than one category only if providing more than one system requiring different categories. In general for horizontal cable, use Category 6 for all voice and data circuits on Army and Navy projects, and use Cat 5 or better for USAF projects.

#### 2-3.3.1 Copper Outlet/connector

Copper outlet/connector must be TIA/EIA category 6 (Cat 6) for Army and Navy projects, and Cat 5 or better for USAF projects.. All connectors must be 8-pin/8-position

insulation displacement terminations wired per T568A. The T568B configuration must only be used by exception if required to maintain system configuration uniformity, security or other user-specified reasons. Category 3 (Cat 3) rated connectors must not be used in new construction, or rehabilitation projects. Copper outlet/connector and plugs should be unkeyed unless the user requires keyed outlet/connector and plugs to maintain system uniformity, security, or other user specified reasons.

#### **2-3.3.2 Fiber Optic Outlet/connector**

Terminate all fiber optic work area cables in dual 568SC connectors. Provide fiber optic connectors in accordance with the paragraph entitled "Fiber Optic Terminations" in this UFC. The default choice for fiber optic outlet/connector must be TIA/EIA "SC" type (568SC). Other type connectors (small-form-factor) (MT-RJ, VF-45, etc.) may be substituted as required by the user. Small form factor connectors (available from several manufacturers), offer a potential for significant installation cost reduction. Any type of fiber connector used must meet the performance requirements specified within Annex A of TIA/EIA-568-B.3, and meet the requirements of the corresponding TIA Fiber Optic Connector Intermateability Standard (FOCIS) document.

#### **2-3.3.3 Coaxial Outlet/connector**

Coaxial outlet/connector should normally be "F" type connectors. Use of other type connectors (i.e., BNC, etc.) should be considered only if specifically required by the user. The designer must coordinate with the cable service provider where franchise agreements are in place. The Navy requires that all passive CATV devices support 1 GHz bandwidth.

#### **2-3.4 Outlet/Connector Markings**

Each communications outlet must have a unique identifying number in accordance with TIA/EIA 606-A. In the telecommunications room (TR), this unique identifying number must be associated with the position on the patch panel or cross-connect to which the outlet is connected. Each horizontal cable must be labeled both at the outlet and patch panel or cross-connect position in the communications closet. Connector voice and data dedication use may be reassigned as requirements dictate. Note: in the standard cabling scheme, the designations "voice" and "data" are arbitrary and do not imply that one outlet is better than the other, the outlets are identical in capability.

#### **2-3.5 Outlet Types and Density**

The following outlet types are commonly used in military construction projects. Sketches of these outlets are included in Figure 6, of Appendix B. The outlet types do not cover all possible user required configurations. The designer must certify that all user-defined outlets have a corresponding valid requirement, such as fiber for various levels of classification. Outlet configurations must comply with this UFC, TIA/EIA-568-B, and TIA/EIA-569-B. Outlet densities are provided for planning purposes, when actual outlet locations are not known and cannot be determined with available information. The designer can develop reasonably accurate total outlet count estimates based on the size and dedicated usage of the space. These factors fall within the ranges given in TIA/EIA-569-B, and are based on gross area (overall building footprint without deducting for hallways, equipment rooms, restrooms, etc.). See Figure 9, of Appendix

B, for a typical building floor plan. For USAF projects all administrative facilities and administrative spaces in other types of facilities must be equipped with one standard telecommunications outlet for each 48 square feet (4.5 square meters) of net office space. Outlet densities and locations for all special-purpose spaces and non-administrative facilities must be determined by the user and the BCSO and must follow the guidelines in TIA/EIA-569-B.

**Table 2-1 Outlet Types**

<u>Facility Space Category</u>	<u>Outlet Configuration</u>	<u>Planning Area (SF(SM)) per Outlet</u>
Administrative space, to include Classrooms, and Medical/Clinics	Two 8-pin modular (RJ45 type) outlet/connector in a double gang outlet faceplate, one connector labeled voice use and one labeled data use.	80(7.5)
Headquarters and Special Users	Minimum of two 8-pin modular (RJ45 type) outlet/connector in a double gang outlet faceplate, one connector labeled voice use and one labeled data use, with additional 8-pin modular and/or fiber outlet/connectors as required.	80(7.5)
Systems Furniture	Two 8-pin modular (RJ45 type) outlet/connector in a modular furniture outlet faceplate with outlet box extender, one connector labeled voice use, and one connector labeled data use.	See below
Non-Admin Spaces (CDCs, Chapels, Rec-centers, etc.)	Two 8-pin modular (RJ45 type) outlet/connector in a double gang outlet faceplate, one connector labeled voice use and one labeled data use.	500(46.5)
Barracks Space/Bachelors Quarters	See below	See below
Warehouse space	Two 8-pin modular (RJ45 type) outlet/connector in a double gang outlet faceplate, one connector labeled voice use and one labeled data use.	5000(465)

Wall and Pay Phone Outlet	One 8-pin modular (RJ45 type) connector in a single gang outlet faceplate with mounting lugs, labeled voice use.	As needed
Family Housing units	See below	See below

### 2-3.5.1 Family Housing Units

#### 2-3.5.1.1 Army Family Housing

The designer must determine the minimum outlet quantity for Army Family Housing (AFH) units based upon the number of rooms in the AFH unit. In general provide one telephone outlet and one CATV outlet (as a minimum) in each of the following rooms: kitchen, living room, dining room, family room/area, each bedroom, and any other logical location deemed appropriate. Copper outlet/connector must be TIA/EIA category 6 (Cat 6) for Army and Air Force projects.

#### 2-3.5.1.2 Navy Family Housing

The designer must provide a complete structured telecommunications system in accordance with TIA/EIA-570-B for Navy family housing units. Provide Grade 1 wiring for units with less than 1500 square feet (140 sq m) and Grade 2 wiring (excluding optical fiber) for units with 1500 square feet (140 sq m) or more. Locate the distribution device adjacent to the residential load center. In addition to outlet locations required by TIA/EIA-570-B, provide two outlets on opposite walls in the living room, family/great room, den/study, and each bedroom. Provide one outlet in dining room and garage if provided. Copper outlet/connector must be TIA/EIA category 6 for Navy and Marine Corps Intranet (NMCI) projects.

#### 2-3.5.1.3 Air Force Family Housing

The designer must provide a complete structured telecommunications system in accordance with TIA/EIA-570-B for Air Force family housing units. Residential Telecommunications Cabling Standard Telephone outlets must consist of 4-pin/4-position non-keyed CAT 3 or better modular USOC RJ-11 jacks. CATV outlets must be "F"-type jacks. Locate jacks in the kitchen, living room, family room, and all bedrooms adjacent to a 120-VAC, 60-Hz (or host country standard voltage and frequency as applicable) duplex electrical receptacle. Telephone and CATV outlets must be wall-mounted. Locate outlets or provide additional outlets to enable maximum furniture placement flexibility.

#### 2-3.5.1.4 Barracks/Bachelor Quarters

For Army barracks projects provide one 8-pin modular (RJ45 type) connector in a single gang outlet faceplate, labeled voice use. In BEQ/BOQ/SEBQ/etc, provide one single RJ-45 outlet in each room of the suite; i.e., bedroom & living room, configured per TIA/EIA-570-B. For Navy projects provide two telecommunications outlets for each resident on opposite walls consisting of two 8-pin modular (RJ45 type) outlets wired per

T568A, except in open bay berthing. For example: a 1+1E suite is designed to house 1 occupant by assignment therefore a minimum of 1 separate line and 2 outlets on opposite walls are required. A 2+2 suite is designed to house up to 2 occupants; therefore 4 outlets (two per room) are required. For Air Force quarter's telephone outlets must consist of 4-pin/4-position non-keyed CAT 3 or better modular USOC RJ-11 jacks. CATV outlets must be "F"-type jacks. Locate jacks in the kitchen, living room, family room, and all bedrooms adjacent to a 120-VAC, 60-Hz (or host country standard voltage and frequency as applicable) duplex electrical receptacle.

### **2-3.5.2 Systems Furniture Wiring**

The designer must specify a minimum of one systems furniture outlet per single occupancy cubicle. The designer must specify a minimum of two systems furniture outlets per cubicle designated for servers, printers, copiers or faxes. When systems furniture is installed as part of the construction contract, insure that systems furniture specifications include TIA/EIA-568-B and TIA/EIA-569-B cabling and raceway standards.

### **2-3.6 Utility Rooms and Closets**

All utility rooms and closets, such as electrical, mechanical and telecommunications, must be wired with at least one wall mounted telecommunications outlet, with a mounting lug face plate.

### **2-3.7 Elevators**

For buildings with elevators, a four-pair copper cable with an eight-position modular outlet adapter must be installed for each elevator. The exact location of the outlet assembly must be verified with the elevator installer or Contractor.

### **2-3.8 Safety, Courtesy, & Convenience**

Provide wall outlets at all logical locations to support safety, courtesy, & convenience. Examples include safety: barracks hall, laundry room; courtesy: building lobby/entrance, stairways; convenience: break rooms, rear (unmanned) entrances.

### **2-3.9 Building Automation Systems**

When requested by the building support systems planner, provide wall outlets at identified locations to support building automation systems. For example, one such outlet may be a direct digital controller (DDC) outlet for the HVAC system. The IS/IT-designer does not have primary responsibility for identifying these circuits, and should defer to the building support systems planner.

## **2-4 BUILDING TELECOMMUNICATIONS WIRING**

The following information pertains to horizontal cable and backbone cable. All horizontal and backbone wiring must be designed in a star-configuration as defined in TIA/EIA-568-B.1. All Cables must be terminated within telecommunications rooms, telecommunications equipment rooms, and work areas.

## 2-4.1 Horizontal Cable

The following information pertains to copper and fiber optic cable and cable run lengths.

### 2-4.1.1 Copper Voice and Data

One Category 6 (for Army and Navy) or one Category 5 or better (for USAF) unshielded twisted pair (UTP) cable must be installed to each standard 8-pin modular connector provisioned at the outlet. For example, install two 4-pair UTP cables to a standard administrative outlet, or one 4-pair UTP cable to each single connector outlet. Copper cables must not be split between multiple modular connectors. Use only cable that has passed the Underwriters Laboratory (UL) LAN certification program and is labeled with UL acceptable markings. Plenum cables must be provided in accordance with National Fire Protection Association, Inc. (NFPA) 70, or when directed by the facility safety officer or local building code. Provide terminations in accordance with the paragraph entitled "Copper Termination" in this UFC. The designer must not use 150 ohm shielded twisted pair for new construction. Category 3 (Cat 3) rated cable must not be used in new construction, or rehabilitation projects.

#### 2-4.1.1.1 Copper Termination

Terminations must be performed using an 8-pin (RJ45 type) connector, rated for the category of the installed cable. In a standard cabling scheme, horizontal cables are arbitrarily designated "voice" and "data" to identify and differentiate their purpose. Copper distribution cable must be terminated at the TR on 110-type cabinet or rack-mounted patch panels compliant with Category 6 for Army and Navy projects, or Category 5 or better for USAF projects. Very small projects (i.e., one or two phones) may use a TIA/EIA Category qualified block or backboard mounted patch panel. Cables from the same outlet must be terminated on the same patch panel and individually identified. All terminations must be wired to the TIA/EIA T568A configuration. Do not use T568B wiring configurations unless specifically requested by the user and approved by the authority having jurisdiction. Copper cables must not be split between multiple modular connectors.

#### 2-4.1.1.2 Copper Patch Cables

Copper patch cables must be 4-pair, 24 American Wire Gauge (AWG) stranded UTP cable, rated for Category 6 (for Army and Navy) or Category 5 or better (USAF), with 8-pin modular connectors at each end. Provide sufficient copper patch cables, of various appropriate lengths, to terminate all copper patch panel appearances.

### 2-4.1.2 Fiber Optic Cable

Provide fiber optic cable to each outlet only at the specific request of the user, or the DAA. As a minimum, administrative (including hospital) outlet boxes and faceplates must be sized and configured to allow for the future installation of two strands of fiber optic cable. When the user requires fiber optic cable, multi-mode 50/125-micron cable or 62.5/125-micron should be installed. Single-mode fiber optic cable may be substituted as required by the user. Plenum cables must be provided in accordance with NFPA 70, or when directed by facility safety officer or local building code.

#### 2-4.1.2.1 Fiber Optic Termination

All fiber optic distribution cable must be terminated in cabinet/rack-mounted patch panels, and at the outlet. Do not use ST style adapters for new construction unless specifically required for interface with existing equipment reused on installations. Check with activity for specific requirements for ST adapters. The default choice for fiber optic adapters and connectors must be TIA/EIA "SC" type (568SC). TIA/EIA 604-3A "SC" type connectors are preferred in new systems as the international standard now accepted by the Federal Government. Other type connectors (small-form-factor) (LC, MT-RJ, VF-45, etc.) may be substituted as required by the user. Provide fiber optic adapters and connectors in accordance with TIA/EIA-604 Fiber Optic Connector Intermateability Standard (FOCIS) and the corresponding FOCIS for the type of connector used.

#### 2-4.1.2.2 Fiber Optic Patch Cables

Fiber optic patch cables must be using the same fiber optic cable type and connectors as the patch panels they are interconnecting. Duplex patch cables must be used. Provide sufficient fiber optic patch cables, of various appropriate lengths, to terminate all fiber optic patch panel appearances plus 25% spare.

#### 2-4.1.3 Cable Length

Copper data cable length must be limited to 295 feet (90 m) from patch panel termination in the TR to the data outlet termination in accordance with TIA/EIA-568-B.1. Adjust the average cable length for planning purposes as required (i.e., average measured length). Exception: buildings with collapsed backbones that use fiber optic cables for all data and copper UTP for voice-only, may exceed the 295 foot length.

#### 2-4.2 Backbone Cable

The following subparagraphs pertain to copper and fiber optic backbone cable. The building backbone must have no more than two hierarchical levels of cross-connects. Copper backbone cable must be used only for voice circuits. Data backbone circuits must be fiber optics.

##### 2-4.2.1 Copper Backbone Cable

Multi-pair voice backbone cable must meet the requirements of Insulated Cable Engineers Association (ICEA) S-80-576 and TIA/EIA-568-B.2 for riser rated unshielded twisted pair cable. Conductors must be solid un-tinned copper, 24 AWG. The copper backbone cable originating in the main TR or main cross connect must be terminated in each TR on 110 type, insulation displacement, wiring blocks mounted on the telephone backboard. Provide at least two backbone cable pairs for Army projects and 1.5 pairs for Navy projects, for every outlet connected to the TR served by the backbone cable. Plenum cables must be provided in accordance with NFPA 70, or when directed by the facility safety officer. ICEA specifications are listed in the references, and can be purchased at <http://global.ihs.com>.

### 2-4.2.2 Copper Termination

Termination must be performed using an 8-pin (RJ45 type) connector, rated for the installed cable. All terminations must be wired in accordance with TIA/EIA T568A. In a standard cabling scheme, horizontal cables are arbitrarily designated “voice” and “data” to identify and differentiate their purpose. Twisted pair OSP cable is terminated on the Protected Entrance Terminal (PET). See Figures 4 and 5, of Appendix B, for details. Cross-connects can then be placed from the PET to the first set of 110-type terminal blocks as needed. The first set of terminal blocks provides connection for all backbones and for outlets served by the main TR. For example, in a three-floor building, one backbone cable must be terminated on 110-type blocks on the same backboard as the PET; one backbone cable should be terminated on 110-type blocks in the 2<sup>nd</sup>-floor TR; and one backbone cable should be terminated on 110-type blocks in the 3<sup>rd</sup>-floor TR. A backbone cable connects a second set of 110-type blocks in each TR to a rack mounted, 8-pin (RJ45 type) connector voice patch panel. This panel can be patched to the distribution patch panel, which in turn terminates the Category 6 (Army and Navy) or Category 5 or better (USAF) outlet wiring. Cross-connects can be done by the DOIM/BCSO/Telephone personnel, and jumpers can be installed by the user/Information Mission Area (IMA) department, providing the desired connectivity between the OSP and the inside plant wiring. This design allows maximum flexibility for future moves, additions, and changes.

### 2-4.2.3 Fiber Optic Backbone Cable

For all Army and NMCI projects, a minimum of 12 strands of 50/125-micron or 62.5/125-micron multimode fiber optic cable and 12 strands single mode fiber optic cable must be installed between the main telecommunications room or main cross connect and each TR. If requested by the user, only 12 strands of one type of fiber may be used. For Navy projects, except medical facilities, a minimum of 12 strands of 50/125-micron or 62.5/125-micron multimode fiber optic cable must be installed between the main telecommunications room or main cross connect and each TR. Navy medical facilities require 12 strands single mode and 12 strands of 50/125-micron or 62.5/125-micron multimode fiber optic cable between the main telecommunications room or main cross connect and each TR. Plenum cables must be provided in accordance with NFPA 70, or when directed by local regulations. For all USAF projects the backbone cable must be 12-strand, 62.5/125-micron multi-mode FOC. The backbone cable must be terminated in a patch panel with duplex SC-type connectors installed in an equipment rack or cabinet

Note: The Army Gigabit Ethernet data network architecture dictates the use of single mode fiber optic cable between TRs.

For Navy projects a general guideline in premises applications for backbone cabling is as follows:

- 62.5/125  $\mu\text{m}$  or 50/125  $\mu\text{m}$  multimode optical fiber is recommended for:
  - Distances less than 1.2 mi (2 km)
  - Data rates up to 155 Mb/s.
- Single-mode fiber is recommended for greater distances or higher data rates:

- Distances less than 1.9 mi (3 km)
- Data rates up to 10 Gb/s

#### 2-4.2.3.1 Fiber Optic Termination

All fiber optic backbone cable must be terminated in cabinet/rack-mounted patch panels, at each end. Do not use ST style adapters for new construction unless specifically required for interface with existing equipment reused on installations. Check with activity for specific requirements for ST adapters. The default choice for fiber optic adapters and connectors must be TIA/EIA "SC" type (568SC). TIA/EIA 604-3A "SC" type connectors are preferred in new systems as the international standard now accepted by the Federal Government. Other type connectors (small-form-factor) (MT-RJ, VF-45, etc.) may be substituted as required by the user. Provide fiber optic adapters and connectors in accordance with TIA/EIA-604 Fiber Optic Connector Intermateability Standard (FOCIS) and the corresponding FOCIS for the type of connector used.

#### 2-4.3 CATV or CCTV Cable

When CATV or CCTV requirements are identified, either a 75-ohm broadband coaxial cable or single-mode fiber optic cable system should be installed. Refer to the paragraphs above for fiber optic cable. When a coaxial system is installed, care must be taken to ensure the correct cable is used. The designer must coordinate with the cable service provider where franchised agreements are in place. Plenum cables must be provided in accordance with NFPA 70, or when directed by the facility safety officer. The table below lists cable types with corresponding distance limitation. This table is derived from vendor specifications (Anixter) for coaxial cable. RG-59 must not be used for CATV projects; however, RG-6 should be used to outlet locations and RG-11 for feeder and trunk cables.

**Table 2-2 Coaxial Cable**

Cable	Distance (feet)	Distance (meters)
RG-6	<=250	<=76
RG-11	<=400	<=122
625 Series	>400	>122

#### 2-4.3.1 Community Antenna Television (CATV) Systems

Community Antenna Television Systems are generally referred to as Cable TV. CATV systems must be designed in accordance with the following: Where required, provide a complete system to be owned and maintained by the government including backbone consisting of backboards/cabinets and wire and conduit with outlets and jacks in all offices, and other locations as required by the user. System must be designed in accordance with applicable TIA/EIA, BICSI, and NFPA 70 standards, and must be coordinated with the local CATV service provider. System must include headend amplifier when required by the local provider, amplifiers, splitters, combiners, line taps, cables, outlets, tilt compensators and all other parts, components, and equipment necessary to provide a complete and usable system. System must provide a high quality signal to all outlets with a return path for interactive television and cable modem access. The system must be designed to operate within the 5 to 1000 MHz bandwidth

using 1000 MHz passive devices and a minimum of 750 MHz active devices. Each outlet must have a minimum signal level of 0 decibel millivolts (dBmV) (1000 microvolts) and a maximum of 15 dBmV at 55 and 750 MHz.

Distribution system must be star topology with each outlet connected to a communications closet with a feeder cable or a drop cable and each communications closet connected to the head end equipment with a trunk cable.

Provide cable installed in conduit as follows:

- a. Trunk Cable, RG-11 or 625 series
- b. Feeder cable, RG-11
- c. Drop Cable, RG-6

#### 2-4.4 **Building Infrastructure**

See Figures 1 through Figure 8, of Appendix B, for details. Figure 9, of Appendix B, provides a typical floor plan used in designing a building or office cabling system.

##### 2-4.4.1 **Cable Tray**

Solid bottom, slotted bottom, or welded wire cable tray should be used to provide a centralized cable management/distribution system. See Figure 4, of Appendix B, for details. Provide 1 sq inch (650 sq mm) cross-sectional area of the tray or wireway for each outlet location served. Cable trays shall be designed to accommodate a maximum calculated fill ratio of 50% to a maximum inside depth of 6 in (150 mm). For barracks, the designer should provide 1 sq inch (650 sq mm) cross-sectional area of the tray or wireway for each barracks unit, and not exceed the 50% fill ratio. Ladder cable tray should be avoided for horizontal distribution. Provide 12 inches of clearance above cable trays for future access. Designers must coordinate with other disciplines to insure clearances can be achieved.

##### 2-4.4.2 **Enclosed Duct (Raceway)**

When a building design does not provide for installation of cable tray, enclosed square duct may be installed. Enclosed duct may also be used in place of cable tray when cable plant requires physical security. For initial design guidance, provide 650 sq mm (1 sq inch) of cross-sectional area of the enclosed duct per outlet location. During actual design, the designer must plan for an optimal fill ratio of 40%. Under no circumstances must a fill ratio of 50% be exceeded. Provide 12 in (300 mm) of clearance above cable trays for future access, as per TIA/EIA-569-B paragraph 4.5.6.2.

##### 2-4.4.3 **Conduit**

Electrical metallic tubing (EMT) conduit must be installed from the cable backbone distribution system, whether cable tray or enclosed duct, to each outlet. Conduit for standard outlets must be a minimum of 1 in (27 mm) EMT conduit. When cable tray or enclosed duct is not used, individual conduits should be installed from the TR to each outlet. Conduit bend radii must be coordinated with cable bend radius. Conduit entries at outlet and junction boxes must be arranged so that cables passing through the box must enter and exit at opposite sides of the box. Do not use metal flex conduit for telecommunications wiring except when installing floor-access boxes in a raised floor,

where floor-access box must be relocated within a specified service area: i.e., 15-20 foot radius typical. An optimal conduit fill ratio of 40% should be accommodated for conduit. Under no circumstances should the designer exceed a fill ratio of 50%. No more than four, four-pair cables may be in a 1 in (27 mm) conduit. Note: conduit must not be used in family housing projects unless it is a high-rise apartment building.

#### 2-4.4.4 Pull Boxes

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

#### 2-4.4.5 Open Office Wiring

##### 2-4.4.5.1 Systems Furniture Wiring

Design systems furniture wiring connections in accordance with TIA/EIA-568-B and TIA/EIA-569-B.

##### 2-4.4.5.2 Multi-User Telecommunication Outlet Assembly (MUTOA)

TIA/EIA-568-B.1 allows MUTOAs in an open office environment. This option provides greater flexibility in an office that is frequently reconfigured. A multi-user telecommunications outlet assembly facilitates the termination of single or multiple horizontal cables in a common location within a furniture cluster or similar open area. The cables from MUTOAs to work stations in system furniture or open office are simply long work area cables supported by the systems furniture raceway. MUTOAs do not include an additional connection, and are limited to terminating a maximum of 12 users. Follow the guidance of TIA/EIA-568-B.1 section 6.4.1 for MUTOA application and design.

##### 2-4.4.5.3 Consolidation Point (CP)

The consolidation point is an interconnection point within the horizontal cabling using TIA/EIA-568-B.2 or TIA/EIA-568-B.3 compliant connecting hardware. It differs from the multi-user telecommunications outlet assembly in that it requires an additional connection for each horizontal cable run. CP's are limited to terminating a maximum of 12 users. Follow the guidance of TIA/EIA-568-B.1 section 6.4.2 for CP application and design.

##### 2-4.4.5.4 Direct Connection

Figure 7, of Appendix B, shows two possible solutions for direct wiring to the systems furniture. This concept is one of a continuous home run from the TR to the furniture outlet. Continuous runs are not the recommended method, and should only be used in open office environments that cannot be readily reconfigured. Testing of the installed cable plant is simplified by providing an end-to-end circuit, without an additional connection point. Follow the guidance of TIA/EIA-569-B, section 6.3.2 for direct connection application and design. Direct connection must not be used on Air Force, Navy and NMCI projects.

##### 2-4.4.5.5 Protection and Separation

The implementers must ensure the cable is protected at all transition points, and that metallic separation is provided between telecommunication and power wiring in the power pole and/or systems furniture track in accordance with TIA/EIA-569-B 10.3 and Article 800-52 of NFPA 70.

#### 2-4.4.6 **Optional Customer Premise Items**

In new construction, particularly in large administrative or medical facility buildings, cable distribution systems must use the cable tray (or duct) and conduit systems as described. In new construction involving small, mixed use (non administrative) facilities, or construction projects involving renovation of existing buildings, use of “J” hooks (Army only), flexible cable tray, and alternative support systems specifically certified for Category 6 (Army and Navy) or Category 5 or better (USAF), cable is permissible, though not desirable. Surface mounted non-metallic raceway may be used in renovation projects where access to the walls for installation of conduit and outlet boxes is not possible, or where historical requirements prohibit the alteration of the building structure. See Figure 8, of Appendix B, for details.

### 2-5 **TELECOMMUNICATIONS ROOM**

See Figures 3, 4, and 5, of Appendix B, for sample closet layouts. TIA/EIA-568-B.1 has replaced telecommunications closet (TC) with telecommunications room (TR). The engineer must use the reference to telecommunications room to more accurately describe the space needed for telecommunications equipment. In new construction or renovation, take into account the heat load of all active electronic equipment to be installed in TRs and equipment rooms. The designer must estimate these loads and coordinate HVAC requirements. Active electronics must be placed in a conditioned space. Follow requirements of TIA/EIA-569-B when active electronics are to be located in telecommunications closets and equipment rooms.

#### 2-5.1 **Multi-Story Buildings**

In multi-story buildings, a minimum of one TR should be located on each floor (small facilities, i.e., air traffic control towers, firing ranges, etc., may use one TR for the entire facility). Collapsed backbone buildings, i.e.: major C2 facilities, may reduce the number of TRs to a minimum in line with the collapsed wiring architecture. TRs on successive floors should be vertically stacked wherever possible. A minimum of three 4-inch (103 mm) rigid steel conduits must be installed between stacked closets on successive floors, in accordance with TIA/EIA-569-B.

#### 2-5.2 **Telecommunications Room Sizing**

TRs must be sized in accordance with TIA/EIA-569-B for all new construction projects with primarily administrative function (small mixed-use facilities should not require full compliance with TIA/EIA-569-B). Generally, the TR should be sized to approximately 1.1% of the area it serves. For example, a 10,000 square foot (1,000 sq meter) area should be served by a minimum of one 11 ft x 10 ft (3.4 m x 3 m) TR. Large Floor areas should be divided into “serving areas” with TRs for each serving area. Each serving area can be no larger than 10,000 square feet (1,000 sq m) as stipulated in TIA/EIA-569-B. TR sizing allowances should be made only in cases of construction projects involving building renovation, and under most circumstances a TR must not be smaller

than 11 ft x 7 ft (3 m x 2.2 m). The designer must avoid irregular sized TRs, such as narrow rooms or odd shapes. Provide adequate space in telecommunications rooms to facilitate tenant owned telecommunications system support equipment requirements in tenant installed freestanding cabinets or racks. Total TR space (as a percentage of the building's area) must be scale upward, to reflect the increased number of circuits in buildings with more than the standard number of circuits to each workspace. Smaller building TRs are covered in Annex B of TIA/EIA-569-B.

### **2-5.3 Room Interior Finishes**

Floors, walls, and ceilings must be treated to eliminate dust. Finishes should be light in color to enhance room lighting. Dropped ceilings must not be installed in TRs.

### **2-5.4 Room Door**

TR doors must be a minimum of 36" (1 m) wide, 80" (2 m) tall, without doorsill, hinged to open outward and be fitted with a lock to control access to the room.

### **2-5.5 Room Location**

TRs must be dedicated spaces not shared with other functions (i.e., electrical rooms, mechanical rooms, etc). TRs should be located centrally in the area they serve. TRs must be located such that maximum copper cable distance from the patch panel through the structured cabling system to the furthest outlet does not exceed 295 feet. In rehabilitation projects, rooms containing transformers, air handling units, etc., should be avoided if at all possible. If shared facilities cannot be avoided, ensure that proper electrical/telecommunications cable separations are maintained per NESC and NEC.

### **2-5.6 Telephone Backboards**

A minimum of one wall should be covered with rigidly fixed 3/4 in (20 mm) A-C plywood, preferably void free, 8 ft (2440 mm) high, capable of supporting attached equipment. Plywood must be fire-rated. Fire rated backboards are TIA/EIA approved and are easier to field verify than the fire retardant paint. When renovating an existing closet that does not have adequate space, the backboard must be sized as large as possible to accommodate the PET and 110-type blocks. See Figure 4 and 5, of Appendix B, for sample backboard layouts.

### **2-5.7 Equipment Racks**

Equipment racks must be floor mounted 19 inches (475 mm) wide located at or near the center of the TR. If mounting requirements for oversize equipment are anticipated, 23 inches (580 mm) may be substituted, however, use only 19-inch (475 mm) equipment racks on Navy projects. In narrow or crowded closets, equipment racks may be floor mounted adjacent to a wall, but must provide a minimum 36 inches (900 mm) space both in front and in back of the rack, behind any installed equipment, and a minimum side clearance of 24 inches (600 mm) on end racks. Provide 100% spare rack capacity based on the amount of rack capacity utilized by the patch panels provided. Spare racks must be provided for the mounting of government purchased and installed LAN equipment. Wall mounted racks may be utilized in small buildings or for small systems.

### 2-5.8 **Equipment Cabinets**

Equipment cabinets should be used where physical security is required, to mount secure or mission critical equipment, in circumstances where controlled access is desired, such as CATV or CCTV, distribution in barracks, or by specific user request. Cable may be terminated in an enclosed 19-inch (475 mm) cabinet to provide enhanced protection for terminations and patching facilities. Use only 19-inch (475 mm) equipment cabinets on Navy projects. Cabinets must provide, at a minimum, sufficient space for current and anticipated future equipment requirements. Equipment cabinets may be floor or wall mounted and should be logically grouped based on the purpose of the equipment they enclose. Cooling fans must be provided in all equipment cabinets.

### 2-5.9 **Unshielded Twisted Pair Patch Panels**

UTP patch panels should be installed in, or adjacent to, the equipment racks or cabinets, which will house LAN equipment. Patch panels should consist of eight-position modular jacks, with rear mounted type 110 insulation displacement connectors, category rated for the UTP system being installed, and arranged in rows or columns on 19-inch (475 mm) rack mounted panels. Nineteen-inch (475 mm) wall mounted may be utilized when necessary, such as at MRI and Radiology locations in Navy medical projects. Jack pin/pair configuration must be T568A per TIA/EIA-568-B. The modular jacks must conform to the requirements of TIA/EIA-568-B, and must be rated for use with the installed cable plant. Provide a minimum spare capacity of 10% for Army projects and 25% for Navy projects. Provide a maximum panel size of 48 jacks for Navy projects.

### 2-5.10 **Fiber Optic Patch Panels**

Fiber optic patch panel should be installed in, or adjacent to, the equipment racks or cabinets, which will house LAN equipment. Patch panel connectors and couplers must be the same type and configuration as used elsewhere in the system. Utilize 568SC duplex connectors on 19-inch (475 mm) rack mounted panels, unless otherwise directed. Twenty-three inch (580 mm) rack mounted panels, or minimum 12x10 inch (300x250 mm) wall mounted enclosures may be utilized when necessary, such as at MRI and Radiology locations in Navy medical projects, or small facilities in Army projects. A 3-foot (1-meter) slack loop of fiber must be provided within each panel, and panels must provide strain relief for cables. Patch panels must properly provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-connection. Provide a minimum spare capacity of 10% for Army projects and 25% for Navy projects. Provide a maximum panel size of 12 SC or RJ-45 and 24 ST ports for fiber panels for Navy projects.

### 2-5.11 **Ladder and Wire Cable Tray**

Ladder type or welded wire cable tray must be used in the TR to provide distribution between the telephone backboard, equipment racks, backbone conduits, and the distribution cable tray.

### 2-5.12 **Room Lighting**

Light fixtures must be mounted a minimum of 9-feet (3-meters) above the finished floor and provide a minimum of 50 foot candles (500 lx) of illumination measured 3-feet (1-meter) above the finished floor.

### 2-5.13 **Room Climate Control**

Each TR must be independently climate controlled, capable of providing year round ambient temperature control (24 hours/day, 365 days/year) to protect all installed electronic equipment. Rooms must be provided with positive atmospheric pressure to exclude dust.

### 2-5.14 **Room Contaminants**

Information system equipment must not be installed in spaces where moisture, liquid or gaseous spillage, or other contaminants may be present.

### 2-5.15 **Electrical Power**

Provide a minimum of two dedicated 120 volt, 20-amp duplex receptacles in each telecommunications room. Each receptacle must be on a separate 20-amp branch circuit serving only that receptacle. Additional convenience receptacles must be provided at 6 ft (1800 mm) intervals around the perimeter walls. For all projects, provide a dedicated 20-amp circuit and a quadraplex receptacle for each 19 in (480 mm) rack or cabinet.

### 2-5.16 **Voice Communications**

Each TR should have one wall-outlet, installed at or near the entry door.

## 2-6 **EQUIPMENT ROOM**

TIA/EIA-569B defines a telecommunications equipment room as “An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect.” The designer should consider utilizing an equipment room for areas that exceed 10,000 square feet (929 sq meters) or buildings that house substantial IT electronics.

### 2-6.1 **Equipment Room Provisioning**

Provision the equipment according to the guidelines established in TIA/EIA-569-B, section 7.12.

#### 2-6.1.1 **Power Requirements**

Provide a minimum of two dedicated un-switched 20- amp, 120-VAC, 60-Hz (or host country standard voltage and frequency) duplex receptacle power outlets, each on a separate branch circuit, for telecommunication equipment. Increase these minimum requirements as necessary to meet equipment loads. Support the equipment with UPS units where continuous equipment operation is required or where economically justified. Provide additional 120-VAC convenience outlets for maintenance and housekeeping.

Back-up all electrical loads in the ER with standby generator power where continuous equipment operation is required or where economically justified.

## 2-7 **GROUNDING**

All unclassified TRs must be connected to the building earth electrode subsystem (EES) in accordance with MIL-STD-188-124B for Army installations and J-STD-607-A for Air Force, Navy and Marine Corps installations. Information on grounding of classified facilities can be found in MIL-STD-188-124B and MIL-HNBK-419-A. Figures 10 and 11, of Appendix B, provide detailed schematics for the signal grounding system. An acceptable grounding system encompasses: fault protection grounds, lightning protection grounds, signal reference grounds, and DC power grounds (when applicable). Refer to NFPA 780 and MIL-HNBK-419-A for proper lightning protection and NFPA 70 for proper fault protection grounding. The telecommunications designer must review project drawing to ensure that the lightning and fault protection grounds are addressed by the appropriate disciplines. The telecommunications designer must ensure that the different grounding systems are not mixed within the building.

### 2-7.1 **Building Earth Electrode Subsystem (EES)**

The building EES forms the primary electrical, life-safety grounding system. Typically, a grounding electrode conductor connects the main building-grounding electrode to the main electrical entrance panel or cabinet. NFPA 70, Article 250 Section III provides guidance on the grounding electrode system and conductor. End user buildings (EUB) and area distribution nodes (ADN) should have a resistance-to-earth of 10 ohms or less, following MIL-STD-188-124B. The switch manufacturers may specify the resistance-to-earth as 5 ohms or less for a telephone switch or Dial Central Office (DCO). The designer should be conscious of the proposed utilization of the facility, and plan accordingly. Sites must provide proper supporting documentation and specifications to the designer to support resistance-to-ground requirements more stringent than that of NFPA 70 or MIL-STD-188-124B for non-voice switch buildings. Proper documentation includes international, national or local codes, Department of Defense and Department of the Army standards, or manufacturers' equipment specifications.

### 2-7.2 **Cable Entrance Grounding**

All metallic shields and strength members for outside plant cable entering a building must be connected to the lightning protection ground system. The designer must ensure that the lightning protection is in accordance with MIL-STD-188-124B and NFPA 780, Standard for the Installation of Lightning Protection Systems, latest issue.

#### 2-7.2.1 **Building Point of Entrance**

NFPA 70 defines the point of entrance as the location where "the wire or cable emerges from an external wall, from a concrete floor-slab, or from a rigid metal conduit or an intermediate metal conduit grounded to an electrode in accordance with 800.400(B)." The Telecommunications Entrance Facility (TEF) is the space housing the point of entrance of the telecommunications service.

### **2-7.2.2 Copper Cable Entrance**

The OSP copper cable shield, armor, and metallic strength member must be bonded to the Lightning Protection Subsystem as close as possible to the building point of entrance with a No. 6 AWG or larger ground wire. The designer should use a non-bonded splice case for the transition from OSP rated cable to interior rated cable, or must indicate that the implementer not install the splice case carry-through bonding conductor. If the designer must extend the OSP copper cable past 50 feet (15 m) in accordance with NFPA 70 section 800.50, the metallic strength member must be bonded to the lightning protection ground as close as possible to the conduit egress point with a No. 6 AWG or larger copper ground wire.

### **2-7.2.3 Fiber Cable Entrance**

The OSP fiber optic cable armor and metallic strength member must be bonded to the Lightning Protection Subsystem as close as possible to the building point of entrance with a No. 6 AWG or larger ground wire. The designer should use a non-bonded splice case for the transition from OSP rated cable to interior rated cable, or must indicate that the implementer not install the splice case carry-through bonding conductor. If the designer must extend the OSP fiber cable past 50 feet in accordance with NFPA 70 section 770.50, the metallic strength member must be bonded to the lightning protection ground as close as possible to the conduit egress point with a No. 6 AWG or larger copper ground wire. If inside/outside cable is used, a cable shield isolation gap must be incorporated.

### **2-7.2.4 Copper Protector Block**

All OSP copper cables must be terminated on primary protector blocks, equipped with 5-pin solid state or gas protector modules. The protector blocks must be bonded to the Lightning Protection Subsystem with a No. 6 AWG or larger copper ground wire. Blocks must be UL listed. Place the protector block as close as possible to the lightning protection ground.

### **2-7.3 Telecommunications Room Signal Ground**

All TRs must have a high frequency signal ground designed in accordance with MIL-STD-188-124B for Army installations and J-STD-607-A for Air Force, Navy and Marine Corps installations. The signal ground should consist of a ground ring around the inside perimeter of the room for TR or a ground bus bar for telecommunications closets. The signal ground ring or bar should be connected to the building EES by using the building steel girders or a ground cable if the girders are not accessible. The size of the grounding electrode conductor of a grounded or ungrounded ac system shall not be less than given in NEC Table 250.66 (Army) or Figure 5.4.4.1 of J-STD-607-A (AF and Navy). The values in NEC Table 250.66 are based on the size of the service-entrance conductors but the grounding electrode conductor is not required to exceed 3/0 AWG copper or 250-kcmil aluminum. The telecommunications designer must ensure that the different signal grounding system does not interconnect with the fault protection and lightning protection sub-systems within the building.

J-STD-607-A uses the following terms for signal grounding: the telecommunications main grounding busbar (TMGB) and the telecommunications-grounding-busbar (TGB)

in place of a signal ground bus bar, the telecommunications bonding backbone (TBB) in place of the ground conductor, and the grounding equalizer (GE).

#### 2-7.4 **Telecommunications Rack and Supporting Structure**

All telecommunications racks and supporting structures (cable trays, ladders, conduits and baskets) within a TR must be bonded to the TR signal ground ring or bus bar as defined in and TIA/EIA-569-B (TGB or TMGB as defined in J-STD-607-A).

### 2-8 **TELECOMMUNICATIONS SYSTEM LABELING**

The following subparagraphs pertain to patch panel, distribution facilities, and outlet labeling.

#### 2-8.1 **Outlet/Patch Panel Labels**

The telecommunications systems labeling must be done in accordance with TIA/EIA-606-A. All outlets and patch panel positions must be labeled as to their function and with a unique identifier code. All devices, outlet locations, and designations must also appear on the system drawings. As a minimum the following must be reflected in the outlet/patch panel labeling:

- Security Level (if applicable)
- Room Number
- Alpha or Numeric Designator
- Labeling must be a minimum of ¼-inch (6mm) high
- Handwritten labels must not be used for the final configuration

#### 2-8.2 **Conformance to Existing Standards**

It is desirable that the labeling system conforms to any existing labeling, to the Director of Information Management (DOIM) or Base Communications Systems Officer (BCSO) standard, or if neither exists to the method described above. All designations must be done in standard commercial labeling. Handwritten labels must not be used for the final configuration.

#### 2-8.3 **Telecommunications Outlet Labeling**

Outlet labeling must be done in accordance with TIA/EIA-606. Each outlet location must be labeled with a unique designator and level of classification, in sequence starting with "A" or "1" and proceeding clockwise around the room. The left or top 8-pin (RJ-45 type), Category 6 (Army and Navy), or Category 5 or better (USAF) compliant connector should be designated for voice and be labeled "VOICE." The right or bottom 8-pin (RJ-45 type), connector should be designated for data and be labeled "DATA." All LAN components in the system must also be labeled with similar designations in accordance with TIA/EIA 606. For fiber optic connections, the left or top fiber optic connection should be labeled "A" and the right or bottom fiber optic connection should be labeled "B."

#### 2-8.4 **Telecommunications Patch Panel Labeling**

Patch panel labeling must be done in accordance with TIA/EIA 606. Each position must be labeled with a unique designator corresponding to the outlet location. In addition to TIA/EIA-606-A requirements, the top or left 8-pin (RJ-45 type), Category 6 (Army and Navy), or Category 5 or better (USAF) compliant port for each outlet location should be designated for voice and be labeled "VOICE." The bottom or right 8-pin (RJ-45 type), port for each outlet location should be designated for data and be labeled "DATA." Fiber-optic port labeling must be done in accordance with TIA/EIA 606. The left or top connection should be labeled "A." The right or bottom connection should be labeled "B." Color-coding in accordance with TIA/EIA-606-A may be added to the labeling.

#### 2-8.5 **Distribution System Labeling**

The distribution system is described in TIA/EIA-606-A for pathways. In addition, all transitions and changes in distribution system size and type must be labeled. Each cabinet must be labeled at the top with a unique designation.

### 2-9 **BUILDING ENTRANCE FACILITY**

The building entrance facility (equipment room) is the demarcation point between the outside plant (OSP) cabling and the inside plant distribution cabling.

#### 2-9.1.1 **The Telecommunications Entrance Facility (TEF)**

The TEF is the space housing the point of entrance of the telecommunications service. The TEF is also the space where the inter- and intra-building backbone facilities join. Telecommunication-related antenna entrances and electronic equipment may also be located in the TEF.

#### 2-9.2 **Protected Entrance Terminals (PET)**

##### 2-9.2.1 **Protector Modules**

The Protected Entrance Terminals (PET) must be equipped to protect the inside plant wiring and equipment from power surges. PET must be provided with TIA/EIA-568-B compliant 110 Type connector blocks or cable stubs to terminate on 110 Type connector blocks.

##### 2-9.2.2 **Sheath Limitations**

If the OSP sheath distance from the building entrance point to the PET or fiber optic connector housing location is greater than 50 cable feet (15 meters); the use of grounded EMT is required.

##### 2-9.2.3 **Stencils**

All PETs must be stenciled with the terminal number and cable count.

#### 2-9.3 **Fiber Termination Device**

OSP fiber optic cables are terminated on optical patch panels. The inside plant fiber optic backbone cables are terminated on optical patch panels in the same or adjacent equipment racks. Patch cables are connected between the patch panels to provide the

desired connectivity. All patch panels must be stenciled with the panel number and the cable count.

## 2-10 TESTING

The designer must specify that all telecommunications cable, installed as part of a project, be tested to the commercial standards for that cable system. All test results and certifications must be provided in a report upon completion of construction to the DOIM or BCSO responsible for system O&M.

### 2-10.1 Unshielded Twisted Pair Tests

All metallic cable pairs must be tested for proper identification and continuity. All opens, shorts, crosses, grounds, and reversals must be corrected. Correct color-coding and termination of each pair must be verified in the communications closet and at the outlet. Horizontal wiring must be tested from and including the termination device in the communications closet to, and including the modular jack in each room. Backbone wiring must be tested end-to-end, including termination devices, from terminal block to terminal block, in the respective telecommunications closets. These tests must be completed and all errors corrected before any other tests are started.

### 2-10.2 Category 5e and 6 Circuits

All category 5, 5e and 6 circuits must be tested using a test set that meets the accuracy requirements of TIA/EIA-568-B.1 and TIA/EIA-568-B.2-1. All test requirements must be completed as specified in TIA/EIA-568-B.1 and TIA/EIA-568-B.2-1.

### 2-10.3 Coaxial Cable

Cable must be tested for continuity, shorts and opens. Characteristic impedance must be verified over the range of intended operation. Cable length must be verified. Cable must be sweep-tested for attenuation over the range of intended operation.

### 2-10.4 Fiber Optic Cable

All category fiber optic circuits must be tested using a test set that meets the accuracy requirements of TIA/EIA-568-B.1 and TIA/EIA-568-B.3. All test requirements must be completed as specified in TIA/EIA-568-B.1 and TIA/EIA-568-B.3.

Unless stated otherwise, tests must be performed from both ends of each circuit. Connectors must be visually inspected for scratches, pits or chips and must be re-terminated if any of these conditions exist.

## APPENDIX A REFERENCES

1. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements
2. ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components
3. ANSI/TIA/EIA-568-B.2 –1 Addendum 1 – Transmission Performance Specifications for 4-pair 100-ohm Category 6 Cabling
4. ANSI/TIA/EIA-568-B.2–4 Addendum 4 - Solderless Connection Reliability Requirements for Copper Connecting Hardware
5. ANSI/TIA/EIA-568-B.3 Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components
6. ANSI/TIA/EIA-568-B.3-1 Addendum 1 –Additional Transmission Performance Specifications for 50/125 Optical Fiber Cables
7. ANSI/TIA/EIA-569-B Commercial Building Standard For Telecommunications Pathways and Spaces
8. ANSI/TIA-570-B Residential Telecommunications Infrastructure Standard
9. ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
10. ANSI/TIA/EIA-526-14A Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant
11. ANSI/TIA/EIA-606-A Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings
12. ANSI-J-STD-607-A-2002, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, Telecommunications Industry Association (TIA), October 2002.
13. EN 50173:1996 Information Technology – Generic Cabling Systems
14. EN 50174-1:2001 Information Technology – Cabling Installation, Part 1: Specification and Quality Assurance
15. EN 50174-2:2001 Information Technology – Cabling Installation, Part 2: Installation Planning and Practices Inside Buildings
16. EN 50174-3:2002 DRAFT Information Technology – Cabling Installation, Part 3: Installation Planning and Practices Outside Buildings

17. ISO/IEC 11801:2002 Information Technology – Generic Cabling for Customer Premises
18. ISO/IEC 14763-1:1999 Information Technology – Implementation and Operation of Customer Premises Cabling, Part 1: Administration
19. ISO/IEC 14763-2:2000 Information Technology – Implementation and Operation of Customer Premises Cabling, Part 2: Planning and Installation
20. ISO/IEC 14763-3:2000 Information Technology – Implementation and Operation of Customer Premises Cabling, Part 3: Testing of Optical Fibre Cabling
21. NFPA 70, *National Electrical Code*, 2005 Edition, National Fire Protection Association, Inc., August 2004.
22. NFPA 780, Standard for the Installation of Lightning Protection Systems, latest issue
23. C2-2002, *National Electrical Safety Code, 2002 Edition*, Institute of Electrical and Electronics Engineers, Inc., August 2002.
24. MIL-STD-188-124B, Grounding, Bonding And Shielding for Common Long Haul/Tactical Communication Systems Including Ground Based Communications-Electronics Facilities and Equipments.
25. MIL-HDBK-419A, Grounding, Bonding, and Shielding For Electronic Equipments and Facilities.
26. UFC 1-300-01 Criteria Format Standard
27. UFC 3-580-10 Design: Navy And Marine Corps Intranet (NMCI) Standard Construction Practices Information System (IS)
28. UFGS-16710 09/2004, Structured Telecommunications Cabling and Pathway System.

## **APPENDIX B FIGURES**

Figure 1 TELECOMMUNICATIONS ROOM ENTRANCE AND BACKBONE DIAGRAM

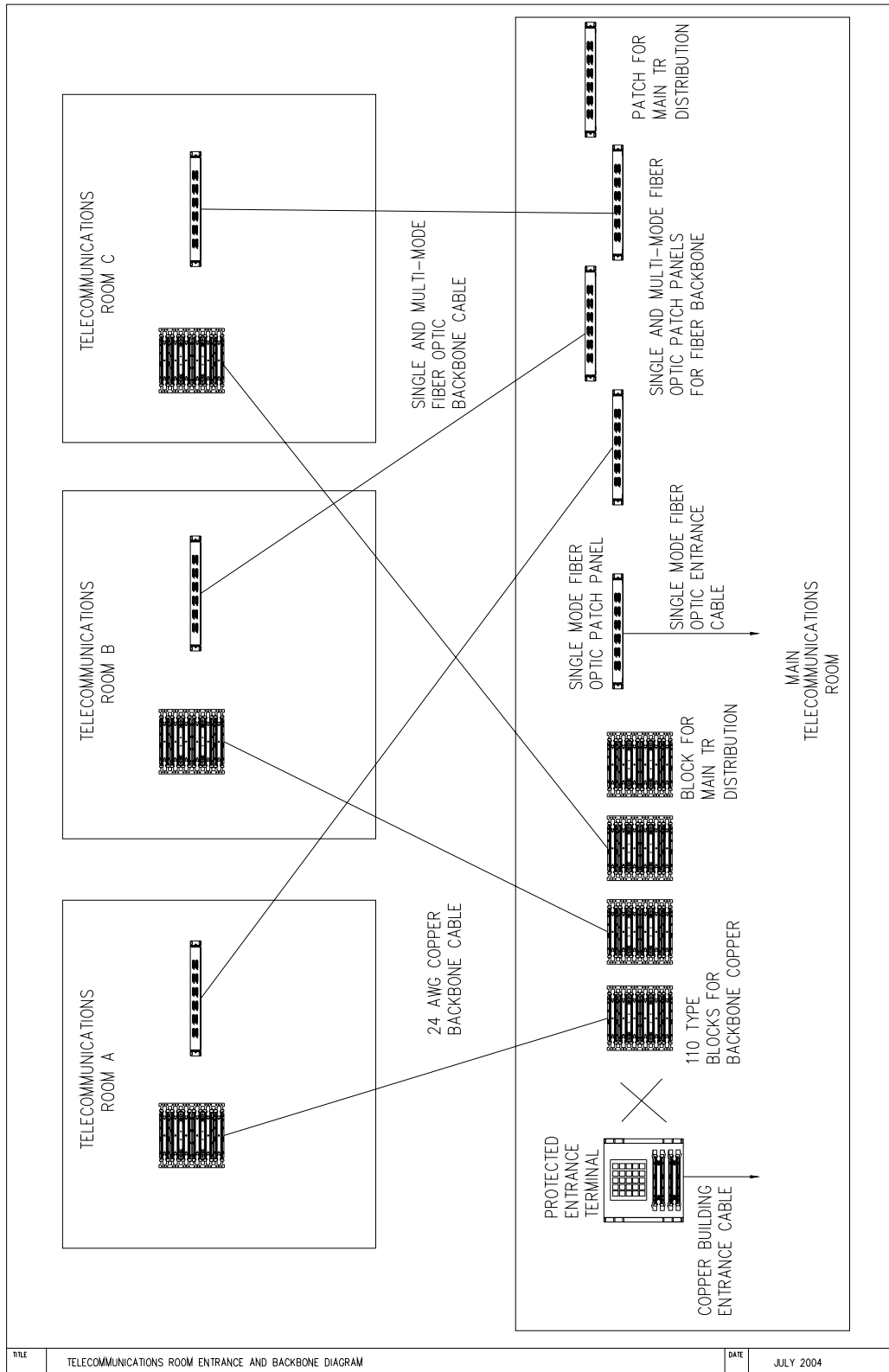
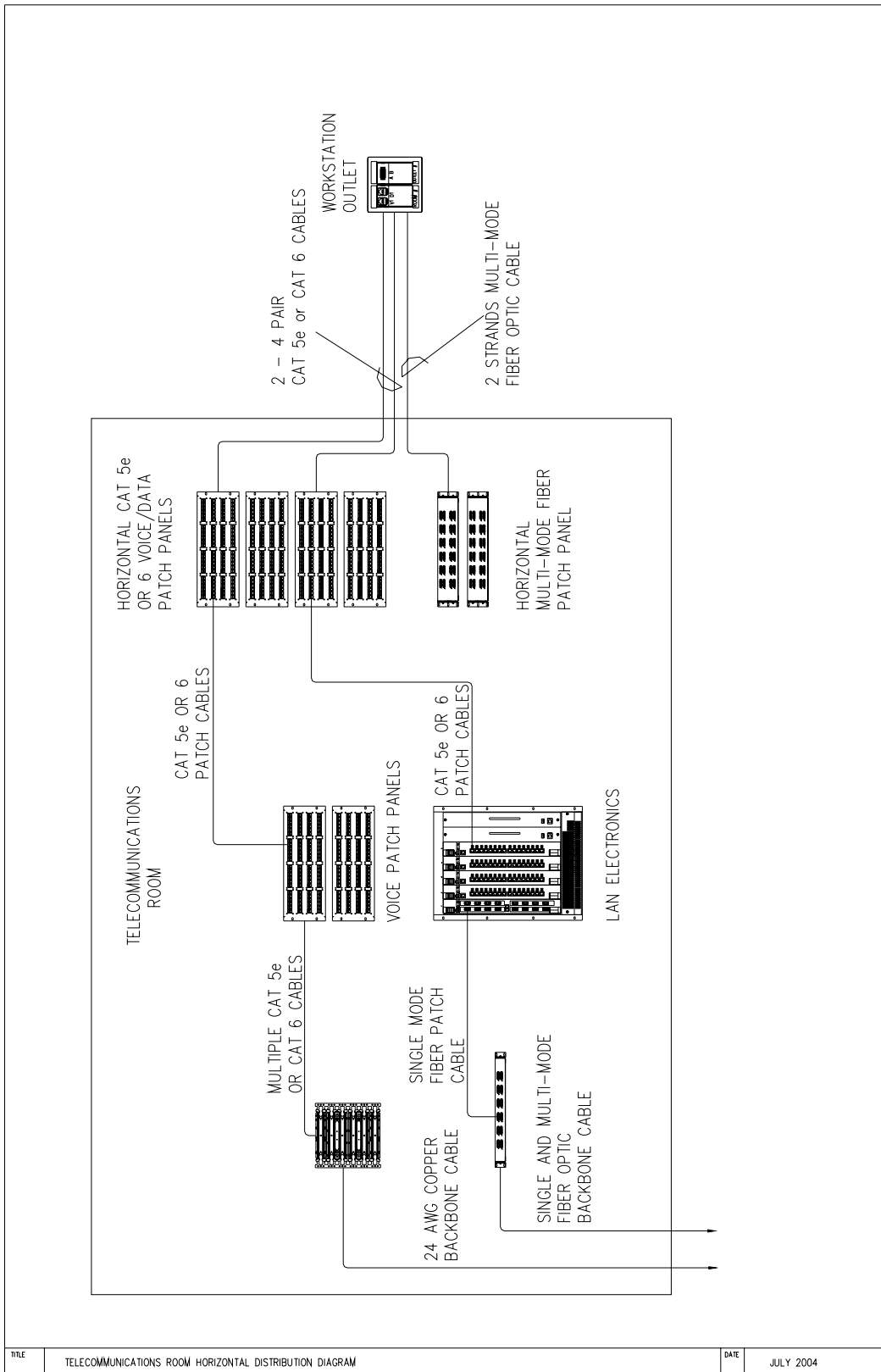
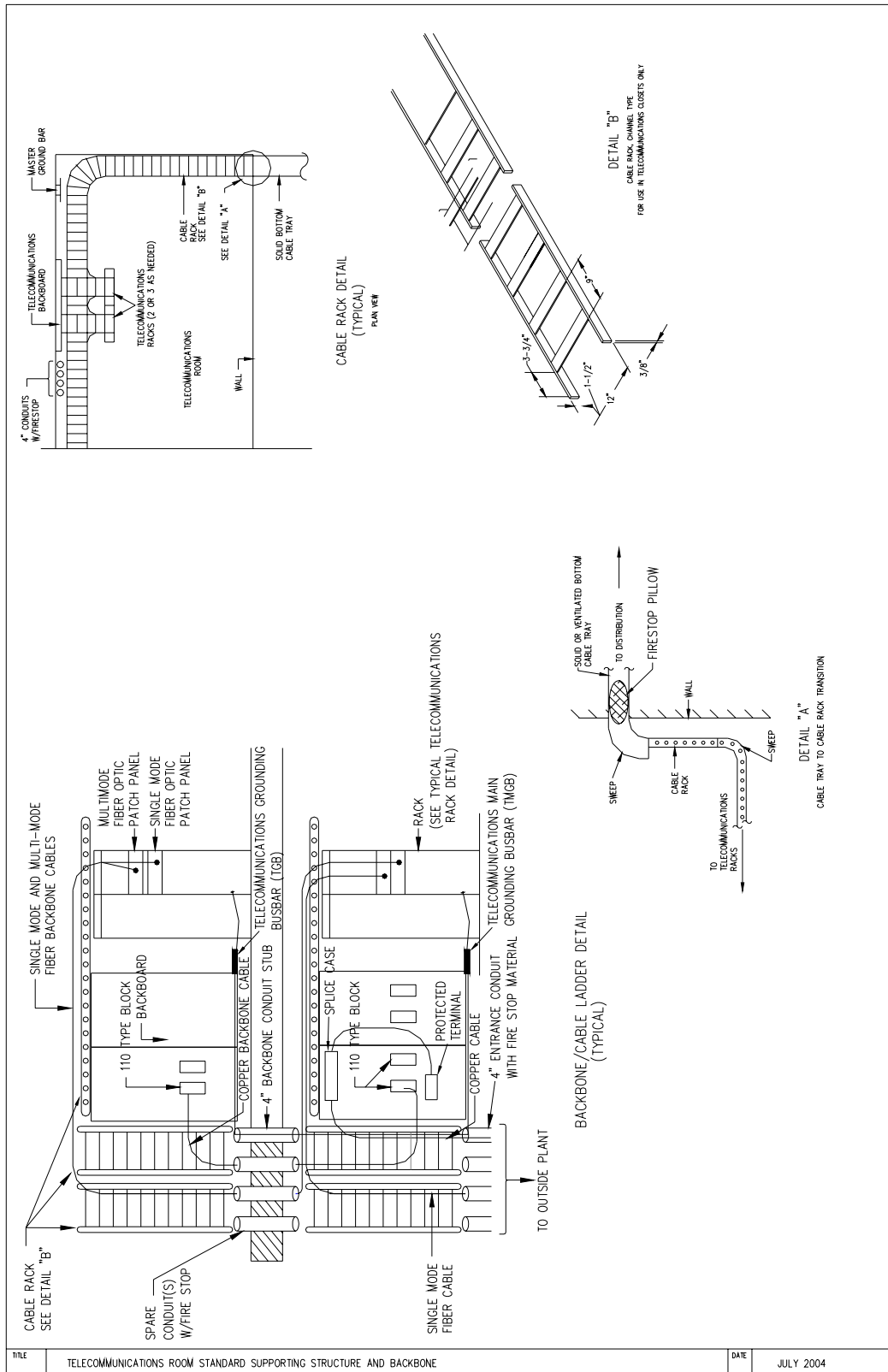


Figure 2 TELECOMMUNICATIONS ROOM HORIZONTAL DISTRIBUTION DIAGRAM



Figures-3

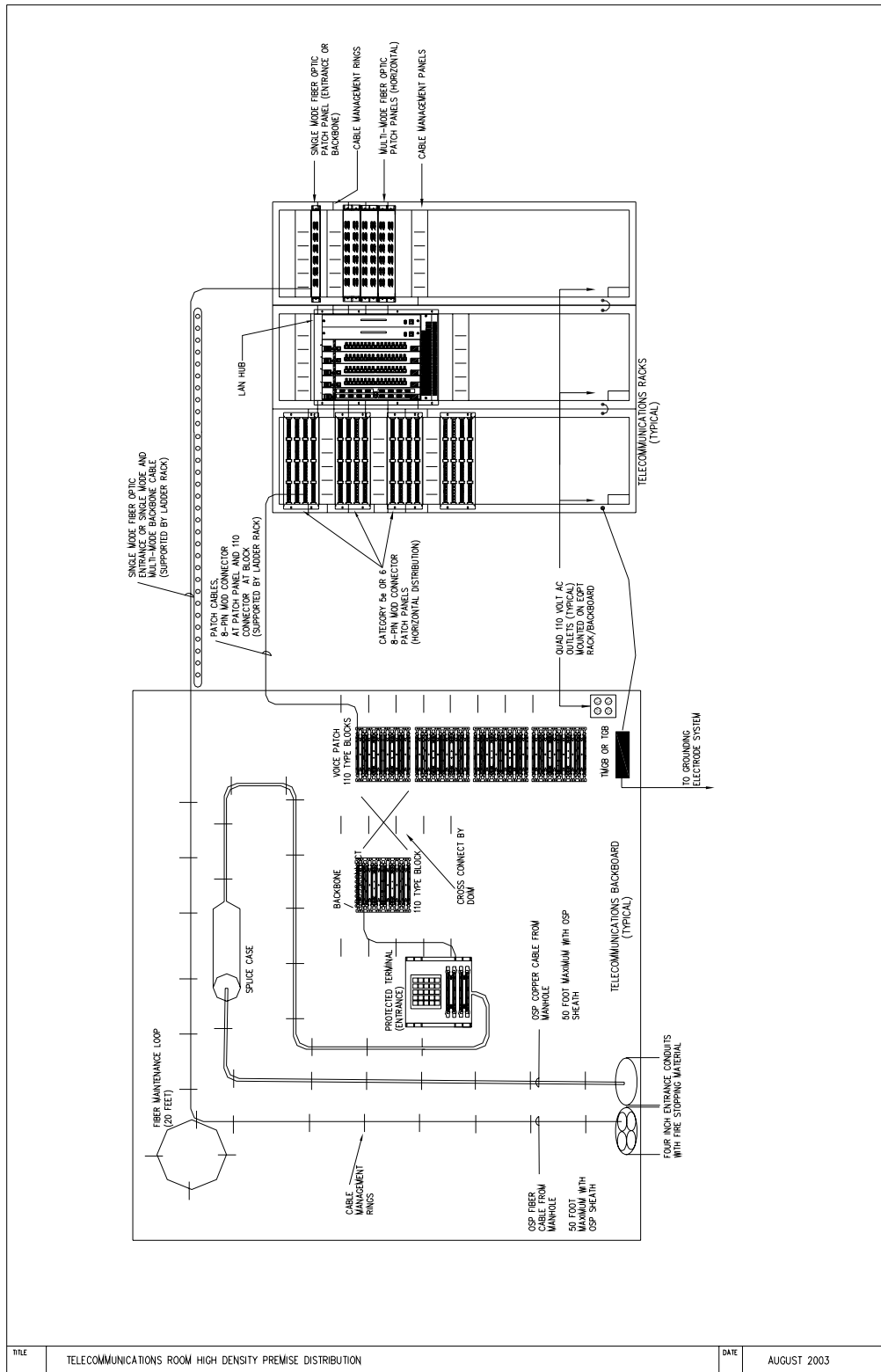
**Figure 3 TELECOMMUNICATIONS ROOM STANDARD SUPPORTING STRUCTURE AND BACKBONE**



Figures-4



Figure 5 TELECOMMUNICATIONS ROOM HIGH DENSITY PREMISE DISTRIBUTION



Figures-6

Figure 6 TELECOMMUNICATIONS OUTLET TYPES

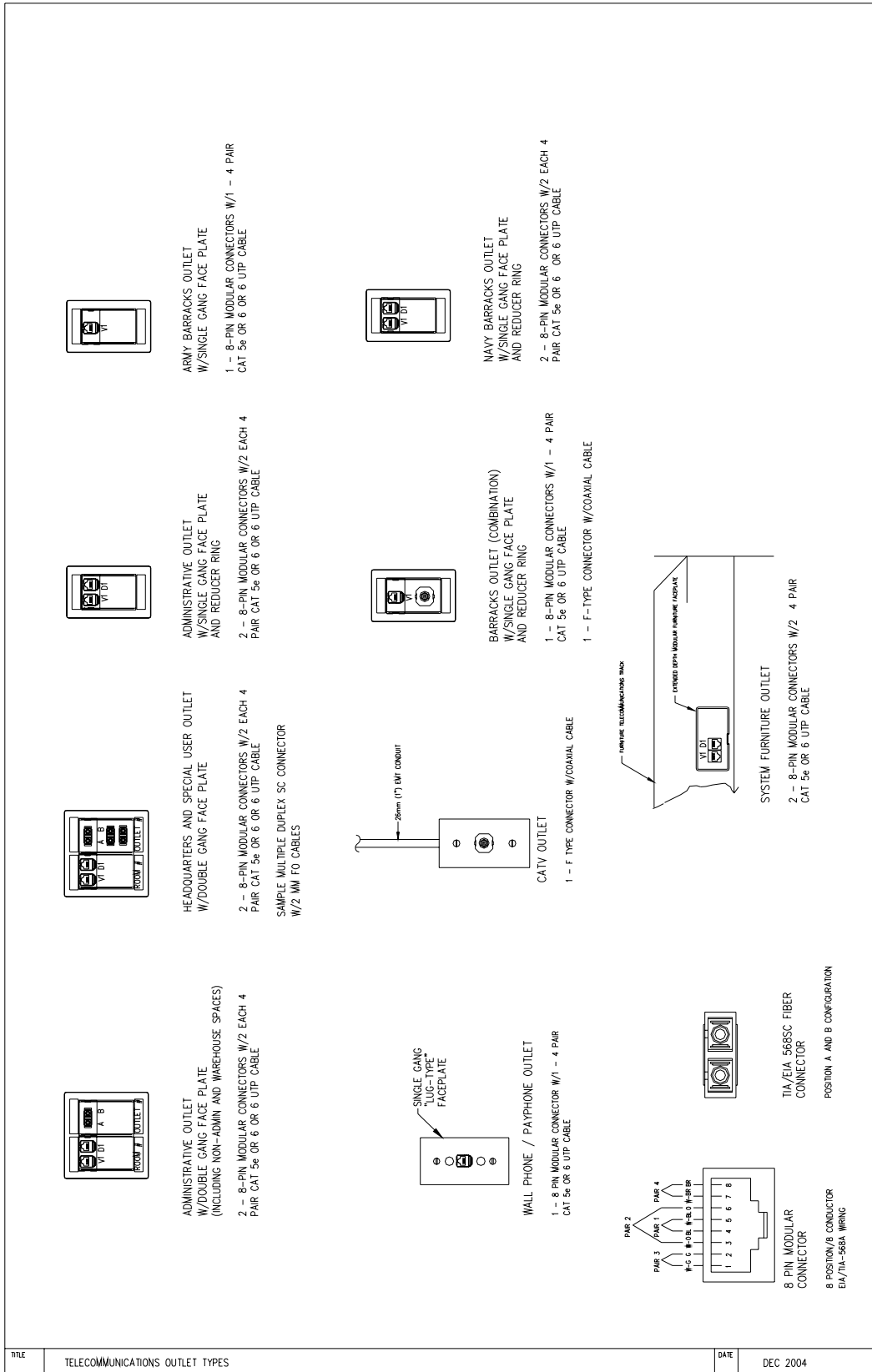
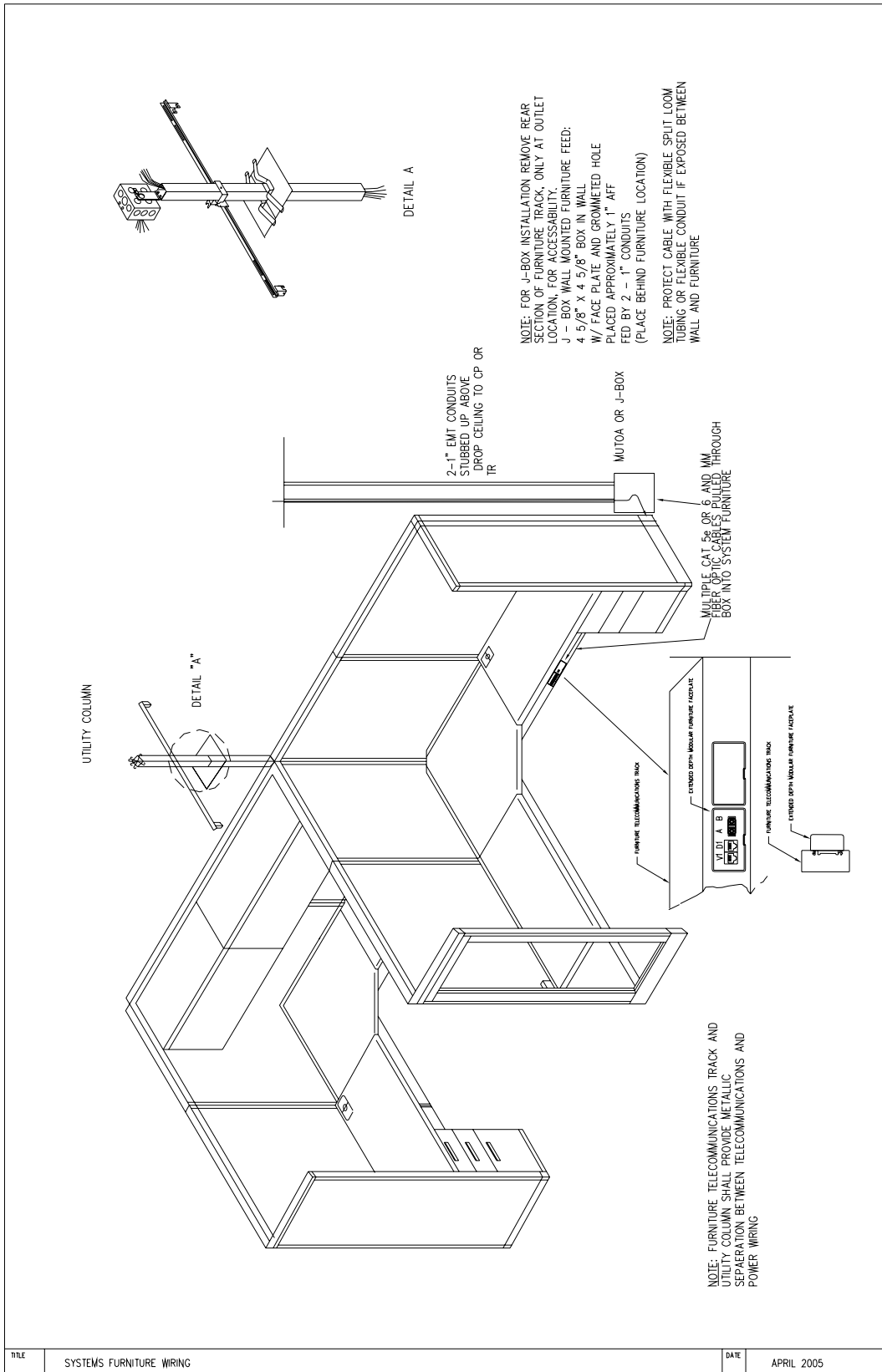
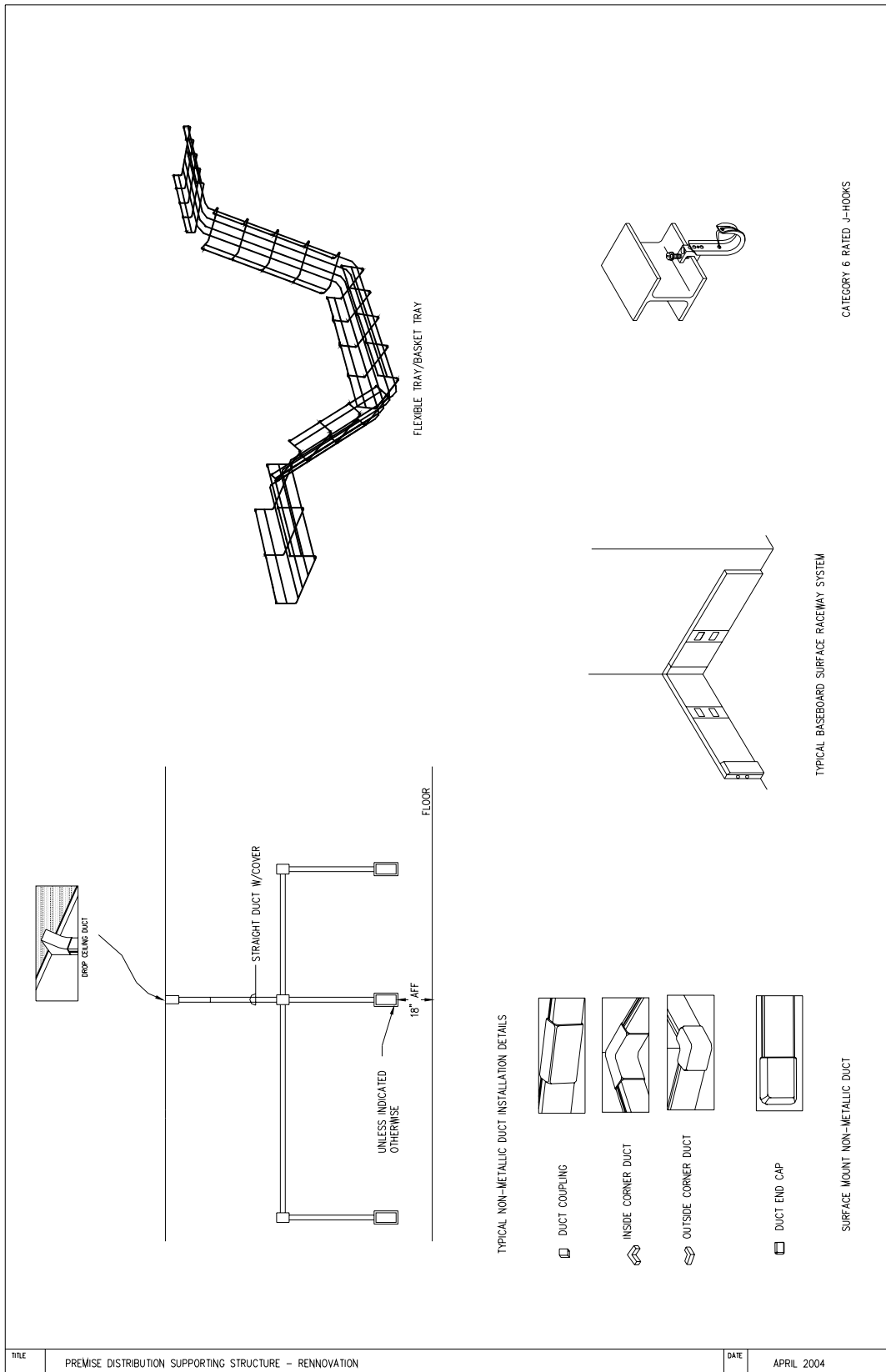


Figure 7 SYSTEMS FURNITURE WIRING



Figures-8

Figure 8 PREMISE DISTRIBUTION SUPPORTING STRUCTURE - RENOVATION

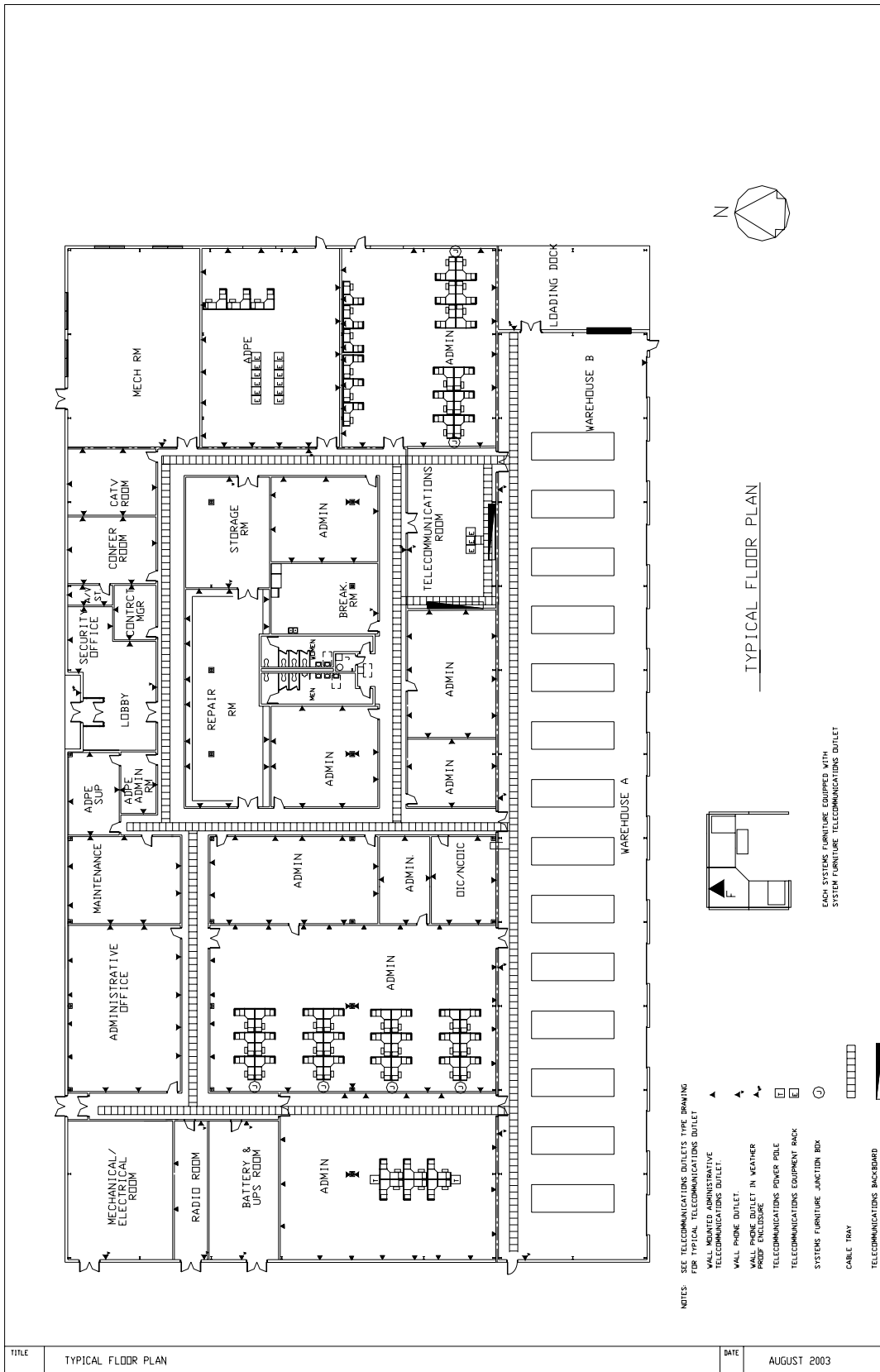


TITLE PREMISE DISTRIBUTION SUPPORTING STRUCTURE - RENNOVATION

DATE APRIL 2004

Figures-9

Figure 9 TYPICAL FLOOR PLAN



Figures-10

Figure 10 J-STD-607A GROUNDING

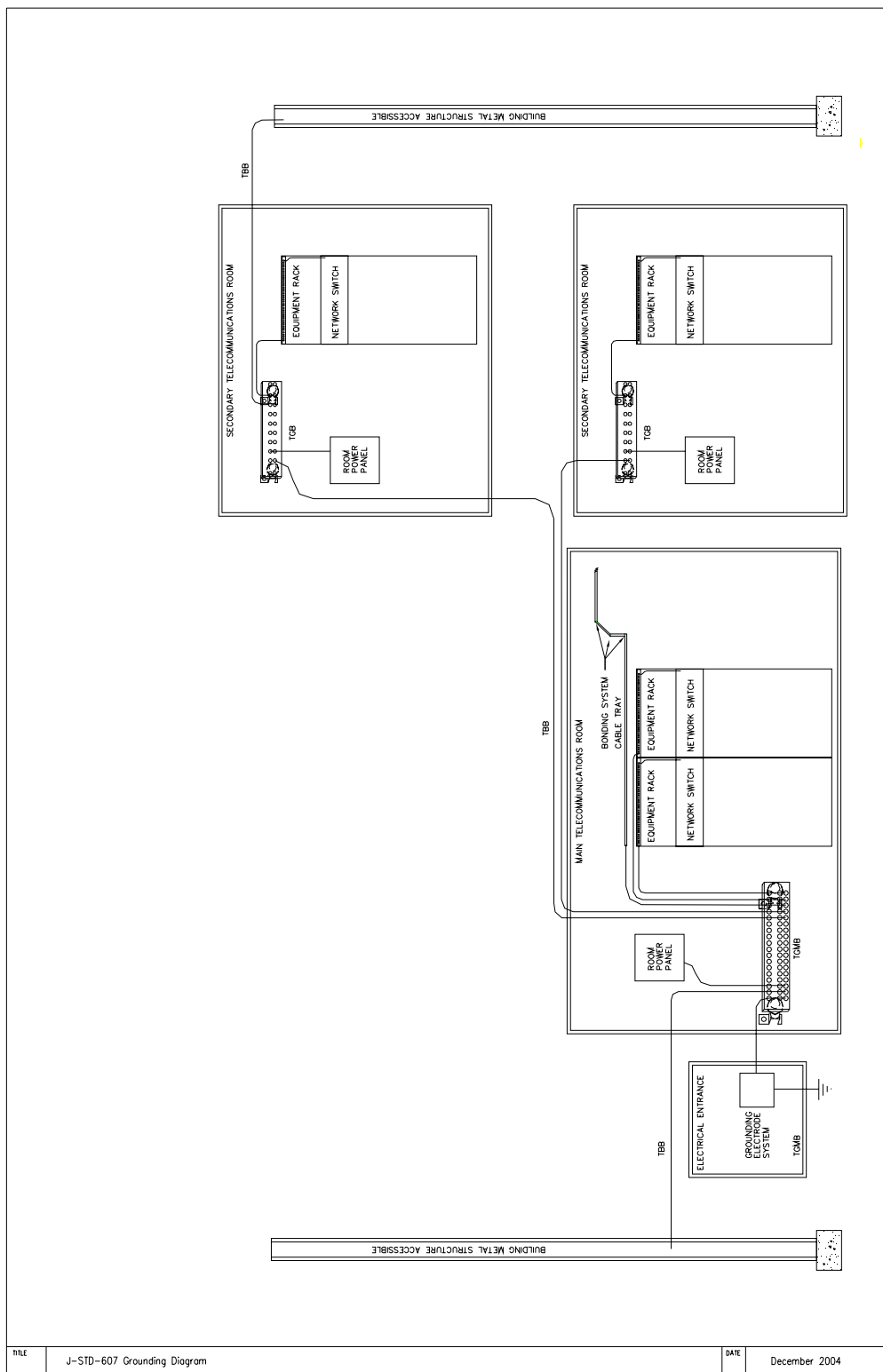


Figure 11 MIL-STD-188-124B GROUND

**SMALL ROOM -Total Ground Subsystem using an Interior Room Signal Ring Ground for the SRGS**

