



World Class. Face to Face.

TELECOMMUNICATIONS DISTRIBUTION DESIGN GUIDE

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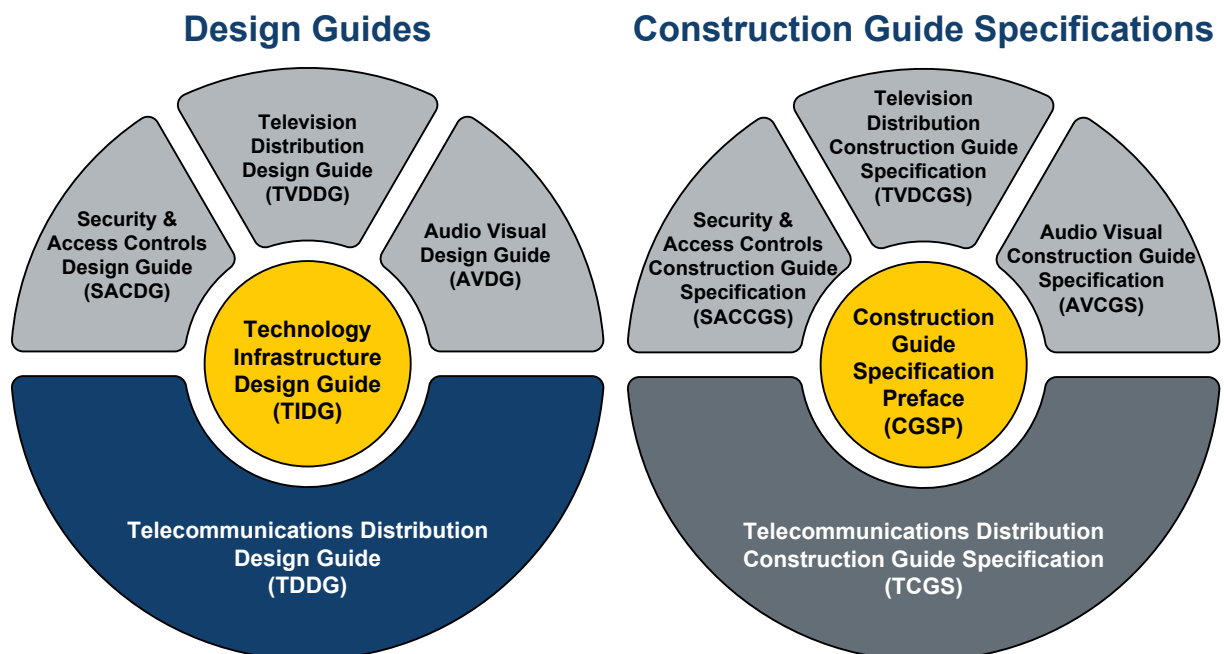
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1 Preface

1.1 Introduction

- A. The Telecommunications Distribution Design Guide (TDDG) is written to communicate the requirements of Washington State University (WSUS) for the design and installation of telecommunications distribution infrastructure at WSUS facilities.
- The TDDG is written for an audience of Architects, Engineers and Designers who are responsible for the design of new or remodeled facilities for WSUS where telecommunications distribution systems currently exist or will be installed.
 - It is also intended for other low-voltage telecommunications Contractors installing telecommunications distribution systems at WSUS facilities.
 - This document also applies to infrastructure designed and installed by WSUS staff, when a formal design is not developed.
- B. The TDDG belongs to a set of documents (depicted below) that comprise the standard design and installation practices for all facets of technology infrastructure and systems at WSUS' Spokane Campus.

Technology Infrastructure Standards Document Set



- C. The Technology Infrastructure Design Guide (TIDG) contains information

common to all of WSUS' Design Guides.

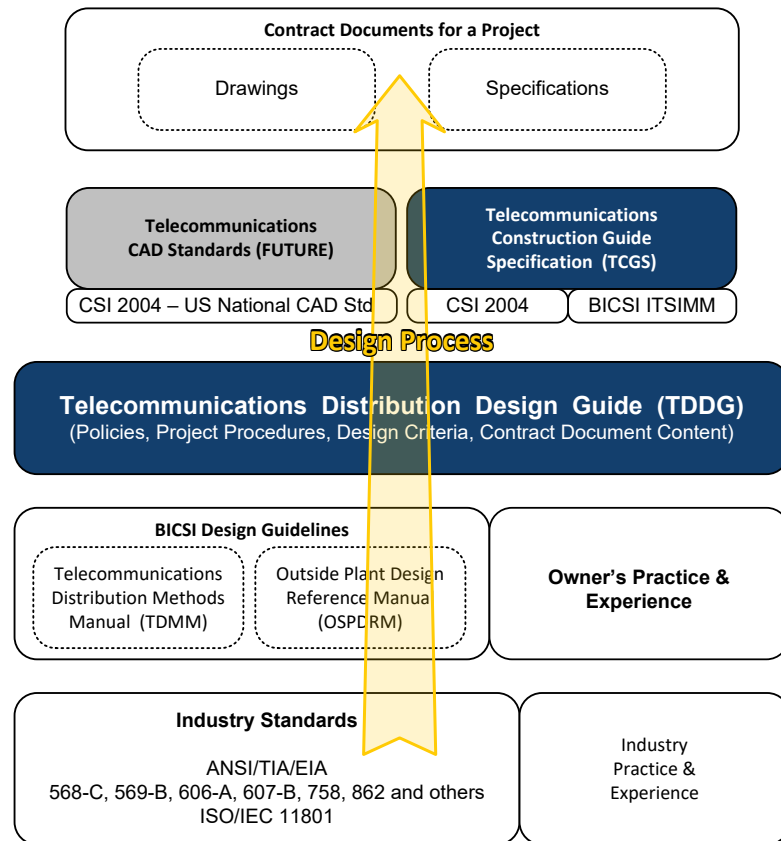
- D. The Telecommunications Construction Guide Specification (TCGS) is a key companion to the TDDG.
 - Designers shall adapt the TCGS “as written” for creating specifications for a particular project according to the instructions in the TDDG. In other words, Designers shall use the electronic specification section documents (provided by WSUS in MSWord format) and then shall make any project-specific edits to the specifications in those documents. Any changes to the specifications shall be done using the “Revision Tracking” features in MSWord.
 - Rewriting the TCGS or modifying the format structure or requirements will not be accepted.
- E. Telecommunications distribution systems designed for WSUS are expected to support and integrate voice, data, video and other low-voltage systems with common media (fiber optic and unshielded twisted pair (UTP) copper cable).
- F. It is the responsibility of the telecommunications distribution systems Designer to coordinate with the other designers on a project (architectural, electrical, mechanical, etc.) to determine that other systems are both compatible with and complementary to the telecommunications distribution systems. It is critical to coordinate between disciplines during the design phase of a project, rather than making adjustments in the field during construction.
- G. This document was prepared by Summit Engineering and Consulting, P.S. and by the Information Technology Services department at the Spokane campus of Washington State University. As technology and needs evolve, the document will be periodically updated.
 - April 2, 2013 – Originally published

1.2 Document Intent

- A. The Design Process diagram below depicts the relationships between the ANSI/TIA/EIA Standards, the BICSI Design Guidelines, the WSUS documents (TDDG, TCGS) and the project-specific Construction Documents. Telecommunications distribution infrastructure at WSUS facilities shall be designed based on the BICSI design guidelines (the TDMM, the OSPDRM and the ITSIMM) and compliant with the ANSI/TIA/EIA Standards as applied by and illustrated in the WSUS TDDG.
- B. The TDDG is intended to be used in conjunction with the TDMM and OSPDRM in order to reinforce selected TDMM content as well as highlight any restrictions and/or limitations on TDMM and OSPDRM content in order to meet the specific requirements of WSUS facilities. The TDDG is not intended to replace or detract from the TDMM or OSPDRM.

The Design Process

Based on Industry Standards and Guidelines and WSUS' Design Guide and Standard Specifications



- C. This document provides directions for making standards-compliant design decisions that will, in due course be reflected in Construction Documents. The Construction Documents for a project will be comprised of drawings and a system specification that properly incorporates telecommunications infrastructure within a project. The TDDG shall be used in conjunction with the TCGS. Drawings shall conform to the guidelines contained in this document for content and completeness, and the specifications shall be based upon the TCGS.
- D. The TDDG is not intended to serve as a master specification, nor for stand-alone use on design build projects. This document should serve as a guide for making standards-compliant design decisions that, in due course, will be reflected in a project specification based upon the TCGS.
- E. The TDDG uses many terms and abbreviations that are common in the telecommunications industry. While a glossary is included in Appendix 6.7 at the end of this document, please refer also to the Glossary in the BICSI TDMM and also the Glossary section at the end of the BICSI OSPDRM for further information.

1.3 Document Structure

The TDDG is organized in the following sections:

1. Preface
 2. WSUS Telecommunications Policies
 3. Project Procedures
 4. Design Criteria
 5. Construction Document Content
 6. Appendices
- A. The **Preface** (this section) describes this document, its intent and its relationship to industry standards, practices and the various audiences affected by the document. It also describes how to use this document.
- B. The **WSUS Telecommunications Policies** section applies specifically to WSUS personnel. It describes internal WSUS telecommunications policies, requirements, standard practices and processes for designing, installing and operating telecommunications infrastructure. WSUS personnel should also be aware of the instructions, requirements and guidelines for Designers contained in the other sections of this document, with respect to their application on both large-scale telecommunications distribution projects and small-scale “moves/adds/changes” (MAC) projects. In addition, these requirements apply to in-house operations and maintenance of existing telecommunications distribution systems.
- C. The **Project Procedures** section describes the required qualifications for telecommunications Designers as well as the procedures that Designers must follow when working on telecommunications infrastructure projects at WSUS facilities. It includes activities that are required throughout the project as well as phase-specific requirements.
- D. The **Design Criteria** section serves two purposes. The first is to describe the general requirements for WSUS telecommunications infrastructure along with the typical features required for different categories of building spaces and construction types. The second purpose is to place limitations on the materials and methods described in the BICSI TDMM and OSPDRM. While the TDMM and OSPDRM describe many materials and methods that are generally accepted in the industry for providing telecommunications infrastructure, WSUS facilities have some unique characteristics that impose limitations on some of the materials and methods that otherwise might be acceptable. Some of the practices discussed in the TDMM and OSPDRM are expressly prohibited in WSUS facilities. Other practices are permitted in certain areas (residential halls, for example) but prohibited in other areas such as academic buildings.

Generally speaking, if the BICSI TDMM and OSPDRM do not describe a particular material or method for use with telecommunications distribution infrastructure, it will not be allowed for WSUS facilities. In addition, the

WSUS TDDG places further restrictions on the use of some materials and methods that the BICSI design guidelines support.

- E. The **Construction Document Content** section defines the minimum level of detail that WSUS requires to be present in the telecommunications portion of the Construction Documents for a project. In this section, the required types of details along with the content in the details are both described. This section also briefly describes the specifications that are required for a project.
- F. The **Appendices** section provides examples and standard forms and diagrams that are required for WSUS telecommunications infrastructure.

1.4 Standards and Guidelines

- A. WSUS has standardized on the ANSI/TIA/EIA¹ Commercial Building Telecommunications Standards series and has adopted the following BICSI² design guide documents as the basis for telecommunications distribution design in WSUS facilities:
 - BICSI Telecommunications Distribution Methods Manual (TDMM) (12th Edition)
 - BICSI Outside Plant Design Reference Manual (OSPDRM) (5th Edition)
 - BICSI Information Technology Systems Installation Methods Manual (ITSIMM) (6th Edition)

The WSUS TDDG is the guide to the application of the ANSI/TIA/EIA Standards, the BICSI TDMM, the BICSI OSPDRM and the BICSI ITSIMM to the unique circumstances present in WSUS facilities and projects.

All references to these manuals shall specifically address only the editions specified above. Newer editions shall be used “for reference only” until authorized by WSUS in writing or through a revised edition of the TDDG.

- B. Adherence to and compliance with the codes, standards and industry practices listed below, along with the WSUS requirements contained in this document, is mandatory.
 - Washington State Rules and Regulations for Installing Electrical Wires and Equipment (RCW 19.28, WAC 296-46 and WAC 296-401A)
 - Washington State Department of Labor and Industries Safety Standards for General Safety and Health (WAC 296-24 Volume 1 Part L)
 - WSUS Capital Planning and Development (CPD) Uniform Design and Construction Standards <http://www.cpd.WSUS.edu/CapitalProjects/UDCS/>
 - National Electrical Safety Code, American National Standards Institute C2

¹ Effective December 29, 2000, The Washington State Department of Enterprise Services has mandated that all Washington State Agencies adopt the ANSI/TIA/EIA Commercial Building Telecommunications Standards as the basis for telecommunications distribution design in State facilities.

² BICSI is widely considered to be the industry source for standards-compliant design guidelines for telecommunications distribution systems. See www.bicsi.org for further information.

- National Electrical Code (NEC), National Fire Protection Association (NFPA 70)
 - Firestop Contractors International Association (FCIA), Manual of Practice
 - ANSI/TIA/EIA 568-C series – Commercial Building Telecommunications Standards
 - ANSI/TIA/EIA 569-B series – Commercial Building Telecommunications Standards for Pathways and Spaces
 - ANSI/TIA/EIA 606-A series – Administration Standard for Commercial Telecommunications Infrastructure
 - ANSI/TIA/EIA 607-A series – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - ANSI/TIA/EIA 758 series – Customer-Owned Outside Plant Telecommunications Cabling Standard
 - ANSI/TIA/EIA 862 – Building Automation Systems Cabling Standard for Commercial Buildings
 - ANSI/TIA/EIA 942 – Telecommunications Infrastructure Standard For Data Centers
 - Fiber Optic Test Standards, TIA/EIA 455 (Series)
 - Optical Fiber Systems Test Procedures, TIA/EIA 526 (Series)
 - Local Area Network Ethernet Standard, IEEE 802.3 (Series)
- C. Any request to deviate from the requirements of the National Electrical Code will not be accepted.
- D. The Designer shall seek approval for designs that are not consistent with WSUS TDDG requirements. Requests to deviate from industry standards or WSUS design solutions will be considered on a case-by-case basis by the WSUS Information Technology Services Project Manager. Designers shall contact the WSUS Information Technology Services Project Manager to discuss proposed alternatives before spending significant time pursuing the option.
- E. The requirements contained in the TDDG are considered to be in addition to those listed in Instructions for Architects and Engineers Doing Business with the Division of Engineering and Architectural Services and the State of Washington Conditions of the Agreement. Where the requirements differ, the issue shall be brought to the attention of the WSUS Facilities Services Project Manager – otherwise the more stringent requirement shall apply.

1.5 Required Manufacturers

- A. Telecommunications distribution systems shall be designed for construction using materials from the current product lines of the manufacturers required by WSUS.
- B. Telecommunications distribution systems shall be designed for construction using materials from the current product lines of the manufacturers upon which WSUS has standardized.

- For copper cabling and related materials, WSUS has standardized on the COMMSCOPE NETCONNECT® product line.
 - For fiber optic cabling and related materials, WSUS has standardized on the Corning Cable Systems LANscape® product line.
 - For racking-related materials, WSUS has standardized on products from Chatsworth Products Inc.® (CPI) and Homaco®.
- C. The Designer is required to incorporate only the manufacturers listed in this document into the design (unless otherwise directed by WSUS) and to design systems that will be suitable for the use of products from these manufacturers. The construction documents shall require that the Contractor's installation workmanship fully comply with the current installation requirements of the manufacturers of these products.
- D. Designs shall comply with the manufacturer's requirements. The construction documents shall require that the Contractor's installation workmanship fully comply with the current installation requirements from the manufacturer, even if those requirements exceed industry standard practices. The manufacturer's full application warranty shall be provided.
- E. The Designer shall incorporate a manufacturer consistently throughout the entire project (unless otherwise directed by WSUS) and design a telecommunications distribution system that will be suitable for the use of products from this manufacturer.

Required manufacturers and their products are identified in the TCGS.

- For example, ladder racking in all telecommunications rooms shall be manufactured by a single manufacturer and cabling system materials shall be manufactured by a single manufacturer. However, it is not required that cabling and ladder racking be from the same manufacturer.

The construction documents shall require that the installation workmanship fully comply with the current installation requirements from the manufacturers of these products.

1.6 WSUS Personnel

- A. There are two specific WSUS personnel roles referenced in this document. The Designer shall interact with these two individuals as direct points of contact:
- **Facilities Services Project Manager (FSPM)** – responsible for project management, project oversight and project budget.
 - **Information Technology Project Manager (ITPM)** – responsible for oversight of all technology considerations, including interpretation of the requirements of this document.

- B. WSUS Telecommunications Policies (Section 2 of this document) applies specifically to WSUS personnel. In addition to the WSUS Telecommunications Policies section, WSUS personnel should be aware of the instructions, requirements and guidelines for Designers contained in the other sections of this document. Also, the TCGS contains additional requirements related to telecommunications distribution system materials and installation methods applicable at WSUS facilities.
- C. WSUS personnel should be familiar with these requirements with respect to their application on both large-scale telecommunications distribution projects and small-scale “moves/adds/changes” projects. These requirements also apply to in-house operations and maintenance of existing telecommunications distribution systems.

1.7 Copyright

Summit Engineering & Consulting retains the copyright for this document. Washington State University is authorized to edit and adapt the document.

Summit Engineering & Consulting has authored similar documents for many other organizations. The document is intended (in part) to describe best practices that are found in some segments of the industry. As a result, portions of this document are similar to comparable content in documents previously prepared by Summit Engineering & Consulting for other organizations. This document does not contain any information that is proprietary or confidential to other organizations.

2 WSUS Telecommunications Policies

This section describes internal WSUS telecommunications policies, requirements, standard practices and processes associated with designing, installing, maintaining and operating telecommunications infrastructure. It is intended for an internal audience of WSUS personnel, including:

- Technical Support Center (TSC)
- Information Technology Services (ITS)
- Events Coordinator
- Administration
- Capital Planning and Development (CPD)
- IS Infrastructure Design Coordinator (ISIDC)
- Facilities
- Other Higher Education Institutions (OHEI)
- Building Stakeholder Design Committee (BSDC)
- Student Affairs
- Anyone that may be involved in the design, installation, maintenance or use of telecommunications infrastructure, network equipment or telephone equipment at a WSUS facility.

Please see Section 2 in the TIDG for internal policies covering all technologies at WSUS.

2.1 Everyone

The following policies apply to anyone that may be involved in the design, installation, maintenance or use of telecommunications infrastructure at a WSUS facility.

2.1.1 GETTING HELP FROM ITS

All requests for IT assistance should be submitted to:

- Call 509.358.7748
- Email spok.it.help@wsu.edu
-

When your request is received, it will be evaluated by TSC and assigned to the appropriate specialists to address your needs.

TSC is most efficient in meeting your needs when you work through our normal channels. We are committed to applying our best efforts to address each request in a timely and professional manner.

2.1.2 DO NOT ALTER CABLING

Cabling supporting technology shall not be altered by anyone outside ITS. Doing so will void the manufacturer's warranty and cause network malfunctions.

Please do not:

- Remove installed connectors
- Attempt to access locked panels
- Remove patch cables

Anyone needing help with cabling should contact ITS for assistance.

2.2 Capital Planning and Development

2.2.1 SPACE ALLOCATION FOR TECHNOLOGY

In the life of a building, technology advances occur, systems become obsolete, and the cabling and equipment components of the technology infrastructure will be changed several times. In order to keep the life-cycle costs low, it is essential that spaces and pathways supporting technology infrastructure are properly sized, properly located and remain accessible.

Please use the following guidelines when allocating space for technology infrastructure in new projects:

2.2.1.1 TELECOMMUNICATIONS ROOMS

When considering the budgeting requirements for a new project, the following items should be included for each telecommunications room (TR):

- TRs should be located centrally within the areas they serve. TRs should be vertically stacked from floor to floor.
- TRs require 24x7x365 air conditioning, with a preference for AC equipment that is located outside the TR with the controls in the TR. Split systems are acceptable for remodel projects.
- TR doors shall swing out of the room.

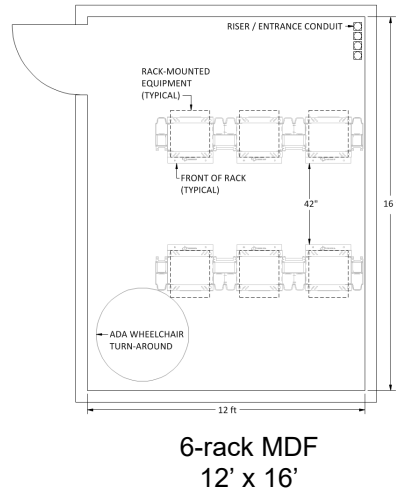
ITS recognizes that floor plan space set aside for technology infrastructure reduces the amount of space that can be allocated to other valuable programs and purposes. In an effort to be frugal with University resources, the telecommunications room sizes below have been developed to be "optimally minimum". This means that the rooms cannot serve their intended purposes and meet Code requirements if they are made smaller in either dimension. The rooms could be increased in size; however, this additional space would not necessarily be put to good use.

- Frequently (during the course of design), value engineering considerations target telecommunications rooms as a source of additional space that might be used for other purposes. ITS considers the spaces described below as being "already value engineered" in advance. ITS will not agree to size reductions to these spaces.

2.2.1.1.1 MAIN (MDF)

The main telecommunications room in the building is typically located on the lowest floor of the building. It is almost always larger than the other telecommunications rooms in the building, and will typically contain 6 or more racks.

Below is an example floor plan for a main telecommunications room (MDF) floor plan:



The WSUS ITPM will work with Capital Planning and Development to whether a larger MDF will be required for a given project.

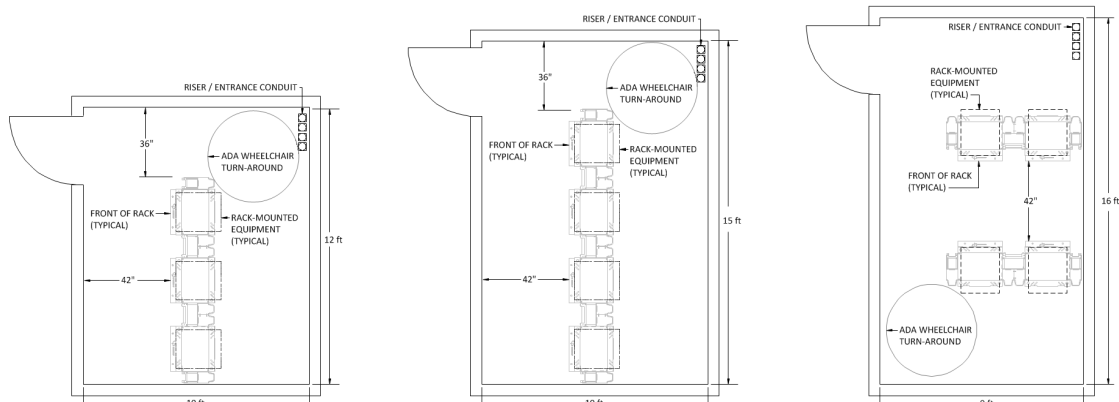
For more detailed examples of telecommunications room arrangements, please see Appendix 6.1.

2.2.1.1.2 SECONDARY (IDF)

In addition to the main telecommunications room, additional secondary telecommunications rooms (also known as “IDF”) will be required. At least one per floor will be needed.

The number of racks required is dependent on the quantity of cabling that the room will serve. Typically, an IDF will need 3 racks in a 10' by 12' room (interior dimensions).

Below are some options for secondary telecommunications room (IDF) floor plan sizing:



3-rack IDF
10' x 12'

4-rack IDF
10' x 15'

4-rack IDF
9' x 16'

The WSUS ITPM will work with Capital Planning and Development to identify whether 3-rack IDFs or 4-rack IDFs will be required for a given project.

For more detailed examples of telecommunications room arrangements, please see Appendix 6.1.

2.2.1.2 CABLE TRAYS

WSUS uses cable trays to distribute cabling throughout its buildings. Cable trays should be installed in corridors or other accessible spaces. Ceilings below cable trays must be accessible. Hard-lid / gypboard ceilings prevent access to cable trays.

Cable trays should not be installed above offices or classrooms for the following reasons:

- It is very difficult to work with ladders in each office. Removing ceiling tiles and working above desks disrupts the users and spreads ceiling dust on their desks. Coordinating around schedules causes inefficiency and longer response times.
- If cable trays are installed in classrooms, all cabling work must be scheduled around class times.

The minimum space required for cable tray along the entire length of main corridor ceilings is:

- A minimum clear space of 12 inches adjacent to the side of the cable tray to allow technicians to stand next to the tray (on a ladder) and add or remove cabling.
- A minimum clear space of 10 inches (head height) above the cable tray to allow cables to be added or removed from the tray.

Therefore, the minimum overall cross-sectional area for a 12"x4" cable tray and the associated working space is 24" wide x 14" high. Wider trays will require more space.

2.2.1.3 OSP PATHWAY

Outside plant (OSP) pathways (ductbank) and spaces (underground vaults/maintenance holes) are required to connect buildings to the campus technology infrastructure.

At a minimum, all major buildings require four 4" OSP conduits. Preferably, buildings will have two sets of four 4" OSP conduits, with each set of conduits routed from opposite sides of the building.

2.2.2 SYSTEM INTEGRATION

Significant technical advances have been made in recent years resulting in numerous systems that now communicate via the campus network. The following are examples of systems or processes that now require secure networking:

- HVAC / environmental control systems
- Mechanical / DDC control systems
- Irrigation control systems
- Security and intrusion detection systems
- Access control systems
- Surveillance video systems
- Handling of personally identifiable information (PII)
- Financial transactions

It is therefore crucial to the success of these systems that Capital Planning and Development coordinate with ITS during the planning and design phases to ensure that adequate network equipment and infrastructure are included in the design.

2.2.3 DOCUMENTATION

2.2.3.1 AS-BUILT / RECORD DRAWINGS

When a construction project is completed, the as-built drawings or (preferably) record drawings need to be made available to ITS as follows:

- Full-size hard-copy printed drawings – the portion of the drawing set that is applicable to technology. The full set is not required, just the sheets that depict the technology features of the project.
- Capital Planning and Development shall maintain a network-accessible archive of both CAD files and PDFs of the record drawings, organized by building. ITS shall have unrestricted access to review the information via the network.

2.2.3.2 CABLE TEST REPORTS

At the conclusion of each project, the telecommunications cabling subcontractor is required (in the project specifications) to provide their cable test reports. The subcontractor is also required to register the manufacturer's warranty for the cabling infrastructure.

The CPD Project Manager should require the test results and warranty registrations at the time that record drawings are submitted, and prior to final payment.

3 Project Procedures

- A. The Project Procedures section contains guidelines for architects, engineers and telecommunications distribution designers regarding the procedures that WSUS requires for projects that include telecommunications distribution systems. This applies both to projects that entail primarily telecommunications distribution work (such as telecommunications infrastructure replacement projects) as well as to architectural projects and other work (such as a new building) that involve telecommunications design.
- B. This section is not intended to supersede the requirements in the State of Washington Conditions of the Agreement or the Instructions for Architects and Engineers, but rather to complement them, providing additional requirements that apply specifically to telecommunications design projects at WSUS facilities.
- C. It is intended that the requirements in this section be considered contractually binding for professional design firms providing telecommunications design services.

3.1 Designer Qualifications

- A. For the purposes of this document, the term “Designer” shall mean a person who is a Registered Communications Distribution Designer (RCDD) who is currently in good standing with BICSI. Telecommunications designs on WSUS projects shall be produced by the RCDD. This means that the security and access controls design shall be produced by the Designer. WSUS’ communications with the telecommunications consultant shall be mainly through the RCDD. On projects where the RCDD is not the prime consultant, the RCDD shall keep the prime consultant (Architect/Engineer (A/E)) informed of all direct communications with WSUS.
 - The Registered Information Technology Professional (RITP) certification from BICSI is not an acceptable substitute for the RCDD.
- B. In addition to the RCDD certification, it is desirable that the RCDD have one or more of the following qualifications.
 - Professional Engineer (P.E.) in the electrical engineering field
 - RCDD/NTS certification from BICSI
 - RCDD/OSP certification from BICSI
- C. In addition, the RCDD shall have the following qualifications.
 - The RCDD shall demonstrate a minimum of 5 years of experience in the design of inside plant telecommunications distribution systems. Experience designing telecommunications infrastructure on WSUS projects is desirable, but is not required.
 - Experience not directly related to the design of telecommunications distribution systems, such as sales and/or marketing, project management, or installation experience, is not sufficient.

- The RCDD shall demonstrate that he/she has designed or has had personal design oversight of a minimum of five projects similar in size and construction cost to the current WSUS project.
 - The RCDD shall be independent from and unaffiliated with any manufacturer associated with the telecommunications distribution system industry.
 - The RCDD shall be completely familiar and conversant with industry and WSUS telecommunications standards.
- D. The services of a professional engineer shall be required to design the following aspects of a complete telecommunications infrastructure.
- Grounding and bonding
 - Firestopping
 - Electrical power distribution in telecommunications spaces
 - Standby Generator and associated other backup power systems
 - Telecommunications room cooling systems
- E. The services of a licensed fire protection engineer shall be required to design the fire protection and life safety systems for the telecommunications infrastructure (e.g., fire suppression, fire alarm system, etc.).

3.2 Procedures Related to Project Phases

In addition to the procedures described in the TIDG for each project phase, the following requirements are specific to telecommunications infrastructure:

3.2.1 CONSTRUCTION OBSERVATION

3.2.1.1 CABLE TRAYS

Verify that the installed cable trays meet the following requirements:

- Wherever cable tray passes through a wall, the wall penetration shall be finished (no sheetrock visible) and firestopped if the wall is a fire-rated wall.
- To protect technicians and cabling, all cuts to cable tray materials shall be finished smooth. Cable trays shall not have rough or sharp edges or points.
- Each segment of the cable tray requires a ground conductor bonding lug.
- Verify that solid-bottom cable tray completely conceals cabling from underside view.

4 Design Criteria

- A. The WSUS TDDG is not intended to be a comprehensive design guide resource for telecommunications design at WSUS facilities. The Designer shall refer primarily to the BICSI TDMM for design guidance. The Construction Documents produced for each project shall be consistent with the installation practices described in the BICSI Information Technology Systems Installation Methods Manual (ITSIMM).
- B. Where ANSI/TIA/EIA standards or BICSI manuals offer multiple choices with a preferred method identified, and where the WSUS TDDG does not select one method over another or define specific requirements precluding use of the preferred method, the ANSI/TIA/EIA or BICSI-preferred method shall be selected.
- C. Where ANSI/TIA/EIA Standards or BICSI manuals identify warnings regarding potential adverse effects from certain design or installation methods, the design or installation method used shall typically be the method with the least potential for adverse effects.
- D. Telecommunications distribution systems shall be designed for construction using materials from the current product lines of the approved manufacturer. For copper cabling and related materials, WSUS has standardized on the CommScope NETCONNECT® Structured Cabling System (SCS) product line. For fiber optic cabling and related materials, WSUS has standardized on the Corning Cable Systems LANscape® product line

In addition to the cabling manufacturer requirements listed in TDDG Section 1.5 Required Manufacturers (above), WSUS also requires the use of cabinets, racking and cable management products from major-market manufacturers that provide substantial warranties on their products.

The Designer is required to incorporate a single manufacturer throughout the entire project into the design (unless otherwise directed by WSUS) and to design a telecommunications distribution system that will be suitable for the use of products from this manufacturer.

These manufacturers and their products are identified in the TCGS.

- For example, ladder racking in all telecommunications rooms shall be manufactured by a single manufacturer, and cabling system materials shall be manufactured by a single manufacturer. However, it is not required that cabling and ladder racking be from the same manufacturer.

The construction documents shall require that the installation workmanship fully comply with the current installation requirements from the manufacturers of these products.

- E. Any request to deviate from the requirements of the National Electrical Code or the manufacturer's 25-year warranty will not be accepted. The Designer shall seek approval for designs that are not consistent with WSUS TDDG requirements through the WSUS Standards Variance Request (SVR) process. Requests to deviate from industry standards or WSUS design solutions will be considered on a case-by-case basis by the WSUS ITPM. Designers may contact the WSUS ITPM to discuss proposed alternatives before spending significant time researching or preparing an SVR.
- F. Telecommunications distribution infrastructure shall fully comply with the current WSUS TDDG, the current ANSI/TIA/EIA Commercial Building Telecommunications Standards and the National Electrical Code (NEC).
- G. The following subsections are arranged to mirror the chapter sequence of the BICSI TDMM 12th Edition (the subsection numbers below are in the form of 4.x where x corresponds with the chapter number in the BICSI TDMM).
 - Each TDDG subsection contains commentary and requirements regarding the application of the BICSI TDMM to WSUS projects. In particular, each section contains limitations and prohibitions on specific materials and methods discussed in the BICSI TDMM.
- H. Please refer to the Bibliography and Resources section and Glossary section of the BICSI TDMM for definitions, abbreviations, acronyms and symbols used for describing and documenting telecommunications infrastructure at WSUS facilities.

Other terms are defined in the Glossary located in Appendix 6.7 of this document.

4.1 Principles of Transmission

Please refer to Chapter 1, *Principles of Transmission* in the BICSI TDMM for general information regarding the design of telecommunications distribution infrastructure.

4.2 Electromagnetic Compatibility

Please refer to Chapter 2, *Electromagnetic Compatibility* in the BICSI TDMM for general information regarding the electromagnetic interference with and clearance requirements for telecommunications infrastructure. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

- A. The BICSI TDMM includes tables listing minimum separation distances from sources of electromagnetic interference (EMI). Telecommunications infrastructure shall not be installed closer than the minimum separation distances listed in the BICSI TDMM. Where the NEC or local codes require greater separation distances than those listed in the BICSI TDMM, the largest separation distance shall be maintained.

- B. Separation distances apply equally to both copper cabling and fiber optic cabling. Even though fiber optic cabling is impervious to EMI, once a pathway is established for fiber it could later be used for copper cabling.
- C. OSP telecommunications infrastructure designs shall adhere to the governing clearance requirements of the NEC and NESC.

4.3 ITS Cables and Connecting Hardware

Please refer to Chapter 3, *ITS Cables and Connecting Hardware* in the BICSI TDMM for information regarding the design of telecommunications cables and connecting hardware. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

4.3.1 COPPER CABLING

- A. Where termination blocks are required in the design of new telecommunications infrastructure at WSUS facilities, 110-style blocks and connectors shall be used only for analog voice. 110-style connections shall also be used on the rear of patch panels for voice and data cabling.
- B. The design of new telecommunications infrastructure at WSUS facilities shall not include the use of the following termination blocks or connectors. This prohibition applies to both voice and data circuits.
 - 66-style blocks or connectors
 - BIX-style blocks or connectors
 - LSA-style blocks or connectors
 - 50-position miniature ribbon connectors

4.3.2 FIBER OPTIC CABLING

- A. Fiber optic cabling shall be terminated at both patch panels and outlets using LC-style connectors.
- B. Where an application requires connectors with more than two strands of fiber (high bandwidth applications, pre-terminated cables, etc.) MPO connectors shall be used in accordance with manufacturer recommendations. Other connector types may be approved by the WSUS ITPM on a case-by-case basis.
- C. All other connector styles (including SC, ST, and MTRJ) are prohibited for new fiber optic cabling at WSUS facilities. Where equipment does not support LC-style connectors, the Designer shall specify hybrid patch cords with LC connectors on one end and the other end matching the requirements of the equipment.

4.3.3 SPLICING

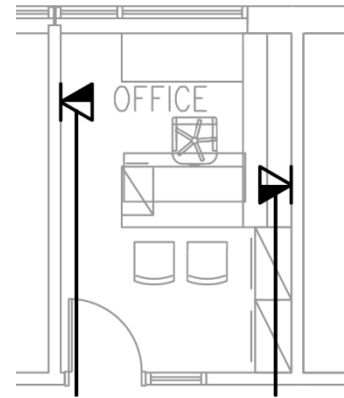
Splicing or coupling copper or fiber optic cable is prohibited for inside plant infrastructure.

4.4 Work Areas

Please refer to Chapter 4, *Work Areas* in the BICSI TDMM for general information regarding the design of work area telecommunications infrastructure. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

4.4.1 PERMANENT OFFICE SPACES

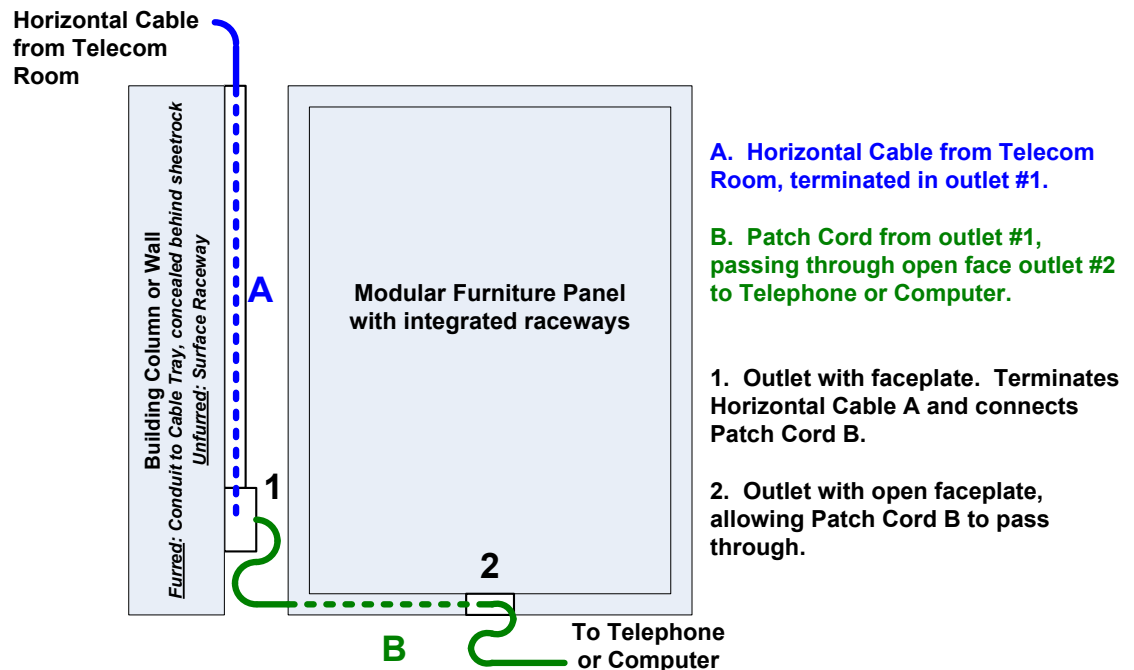
- A. The standard treatment for each permanent office space (walls, door, etc.) is two outlets on opposite sides of the room with one port (one copper cable) per outlet. The outlets shall be arranged as shown in the floor plan below, intended to complement the possible furniture orientations.
- B. If a window prevents outlets on opposite sides, two outlets may be positioned on the same wall if spaced widely apart.
- C. For larger offices, a third outlet (one port) shall be provided on the exterior wall.
- D. Outlets shall not be placed on the wall with the door.
- E. The Designer shall coordinate with the furniture designers/specifiers to make sure that access to power and data outlets is not obstructed by the furniture. The Designer shall involve the ITPM in this effort.



4.4.2 OPEN OFFICE / MODULAR FURNITURE

- A. WSUS prefers to serve open office areas using permanently mounted outlets in the wall nearest the modular furniture. Where modular furniture is not located adjacent to a wall, floor boxes are required.
 - It is usually preferable to route cabling inside concealed conduits or through interstitial wall spaces. Therefore, columns that are wrapped or furred are preferable because conduits and device boxes can be concealed inside.
 - The ITPM may authorize the use of surface-mounted raceway in certain projects for columns that are not able to conceal raceway.
 - Where columns and floor boxes do not exist and cannot be added, utility poles shall be designed as a last resort.

- Where columns are available, raceways shall route cabling down from the ceiling space to two outlets on opposite sides of each column, allowing furniture to sit against the columns on the sides without outlets.
 - Outlets on columns shall have up to 6 ports per outlet.
- B. Raceways integrated into modular furniture shall have separate channels for power and data. The channels shall be designed with abrasion protection features.
- C. The standard treatment for each modular furniture office space (cubicle) is two ports (two copper cables). The following diagram depicts WSUS' preferred method of routing cabling to modular furniture:



- D. Furniture shall not obstruct access to power or telecommunications outlets. Where necessary, access panels shall be provided and/or holes shall be cut through obstructions to allow access to the outlets.

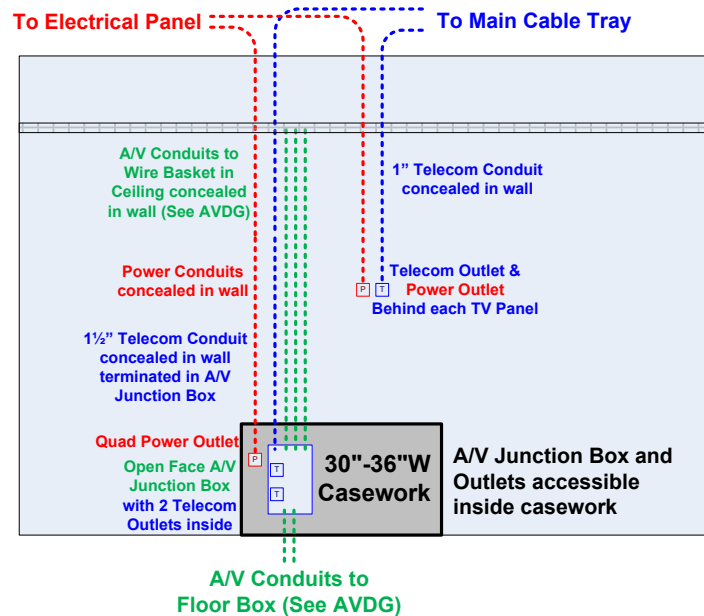
4.4.3 BREAKOUT ROOMS

- A. Small groups meet in "Breakout Rooms." The rooms are typically sized for 4 occupants (6 maximum) and usually do not have a conference-style table. There are no audio / visual features in Breakout Rooms.
- B. One outlet shall be provided in Breakout Rooms. The outlet shall be located on a wall opposite the door and shall be provided with two ports (jacks).

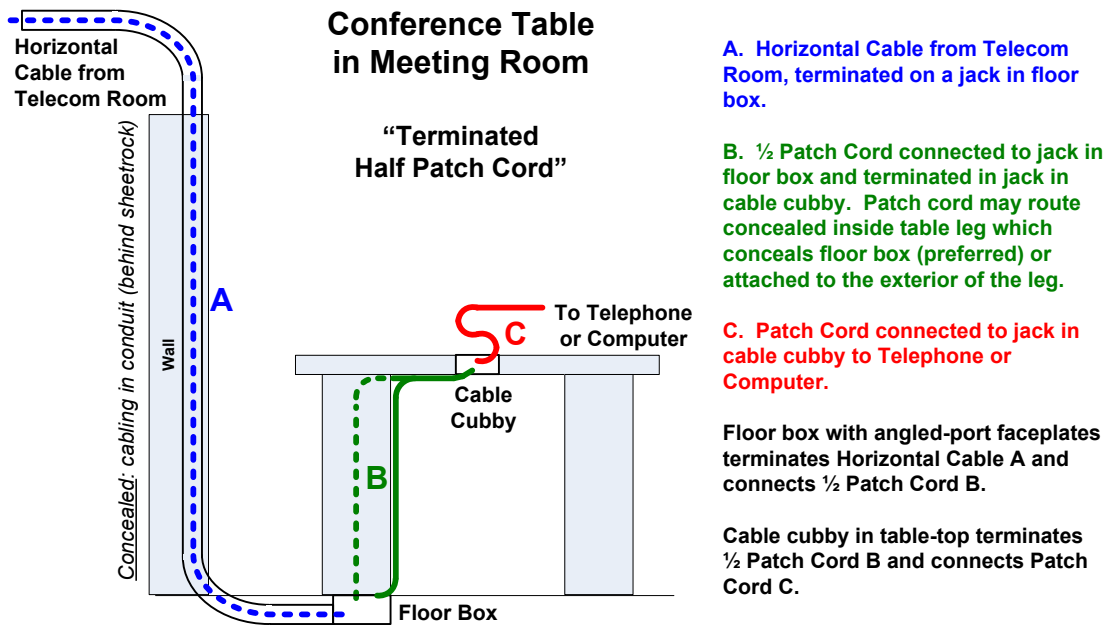
4.4.4 MEETING ROOMS

- A. All Meeting Rooms (conference rooms) shall have video conferencing.
- B. Typically it is desirable to locate a wireless access point in or near each Meeting Room.
- C. On the end wall of each Meeting Room, provide a quad power outlet and two telecom outlets. These outlets shall be accessible inside casework as shown in the wall elevation at right. The Designer shall work with the A/V designer and refer to the AVDG to provide the correct quantities, types and colors of cables for each application.

**Telecom, A/V and Power
Conduit and Box locations
on end wall of Conference Room**



- E. Conference tables shall have floor boxes installed beneath them, with patch cords routed up from the floor box to a table-top connection point providing access to power outlets, data outlets and audio / visual inputs.
- The Designer shall work with the A/V designer and refer to the AVDG to provide the correct quantities, types and colors of cables for each application.
 - See the AVDG for guidelines about the sizing and quantity of floor boxes and cable cubbies required for each conference table application.
 - The diagram below depicts the required method of terminating horizontal cabling in floor boxes and cable cubbies serving conference table applications:



4.4.5 TELECOMMUNICATIONS OUTLETS FOR SPECIAL INDOOR APPLICATIONS

- A. Outlets serving wireless access points (WAP) shall have one port each and shall be mounted near the desired WAP location.
- B. IP video surveillance cameras shall be provided one port each, terminated near the desired camera location.
 - As of this writing, the telecommunications industry is on the verge of establishing a standards-supported³ application where a connector (as opposed to a jack) is installed on the field end of a cable serving fixed-mounted equipment (such as cameras). WSUS approves this solution for camera applications. The Designer shall inquire with the ITPM whether any other devices should also be designed without an outlet and instead be terminated with a connector.
 - The Telecommunications Room end of the cable shall terminate in a patch panel just like any other horizontal cable application.
- C. A courtesy telephone with TDD features shall be provided in a main floor gathering space.
- D. Outlets will be required in mechanical and electrical spaces to provide network services to mechanical control equipment, electrical power monitoring equipment and lighting control panels. The Designer shall address these needs on a project-by-project basis.

³ ANSI/BICSI Doo5 - "Electronic Safety and Security (ESS) Information Technology System (ITS) Design and Implementation Best Practices". Currently under industry review.

- E. Outlets serving digital signage shall be provided with two data ports. WSUS currently uses a Cisco digital media player device mounted in the nearest telecommunications room. A powered adapter is used in the telecommunications room and behind the flat panel television to carry HDMI signals via telecommunications cabling.
- F. Outlets serving televisions shall be provided with two data ports.
- G. Outlets shall be provided to connect power monitoring equipment to the network.
- H. Outlets serving fire alarm panels, elevators, security systems, access control systems, security systems, security scanning stations, point-of-sale equipment, etc. shall be provided under the direction of the WSUS FSPM, ITPM and non-WSUS tenants.

4.4.6 SPECIAL OUTDOOR APPLICATIONS

- A. Outdoor-rated outlets may be required to serve outdoor wireless access points.
- B. Outlets serving security cameras, pay phones, power monitoring equipment, security systems, irrigation controllers, etc. shall be provided under the direction of the WSUS ITPM and FSPM .

4.4.7 OTHER CONSIDERATIONS

- A. WSUS rarely accepts consolidation point solutions.
- B. WSUS considers undercarpet telecommunications cabling (UTC) solutions to be undesirable in most cases. The Designer shall discuss any apparent justifications for undercarpet cabling with the WSUS ITPM prior to its inclusion in a design and shall also discuss the next best alternative to using undercarpet cabling.

4.4.8 WORKSTATION POWER OUTLETS

- A. There shall be at least one general-purpose convenience power outlet (120VAC, 15 Ampere minimum) located within three feet of every telecommunications outlet. The Designer shall discuss any application-specific needs with WSUS IT staff and adjust the power outlet locations and amperage accordingly.
 - In the case of new construction and modernization projects, the power outlet associated with each telecommunications outlet shall be a 4"x4" device box (dual gang) with four power receptacles. It is the Designer's responsibility to coordinate with the electrical engineer to ensure that power outlets are located near telecommunications device boxes.
 - In the case of minor remodel, historical building remodel and telecommunications-only projects, it may be difficult to meet this

requirement. Therefore, where existing power outlets are not located within six feet of each telecommunications outlet, the Designer shall alert the WSUS ITPM and request consideration of the situation on a case-by-case basis.

4.5 Horizontal Distribution Systems

Please refer to Chapter 5, *Horizontal Distribution Systems* in the BICSI TDMM for general information regarding the design of horizontal distribution pathway and cabling. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

4.5.1 DEVICE BOX CONSIDERATIONS

- A. Device boxes intended for use with low-voltage cabling (telecommunications, CATV, etc.) shall not host electrical power receptacles or power wiring. “Combo boxes” (divided, multi-gang device boxes for power and data behind a single faceplate) are not permitted.
- B. Device boxes shall not be mounted in the floor (i.e. “floor boxes”) except where no suitable alternative exists. If device boxes must be mounted in the floor, each device box shall be served with its own individual conduit – floor boxes shall not be “daisy-chained” together.
 - Power outlets may be combined with CATV and telecommunications cabling in floor boxes if the power wiring is routed to the floor boxes separately from the other cable media, and if the floor box provides for metallic barrier segregation of the power and telecommunications cabling within the box.
- C. Within the limitations of the project budget, the provision of spare outlets and spare ports in a work area is encouraged, to provide flexibility for future needs.
- D. Both telecommunications cabling and CATV coaxial cabling are permitted to be terminated in a shared device box.
- E. Device boxes for telecommunications outlets shall be mounted at the same height as the electrical power receptacles.
- F. For projects using Category 6A (Augmented) cabling, the commonly-used 4”x4” device boxes may be too small to provide sufficient cable bend radius; for example, when there are 4 or more cables terminating in the box. Therefore, where device boxes are used with CAT6A cabling, 5”x5” device boxes might be needed, with reducing extension rings and faceplates with angled jacks. The Designer shall verify cable dimensions and bend radius limitations with the cable manufacturer to determine whether larger boxes are required.

- As of this writing, there are two known sources of 5"x5" device boxes:
 - RANDL Industries, Inc. (www.randl-inc.com)
 - Siemon (www.siemon.com)

4.5.1.1 FOR NEW CONSTRUCTION AND FULL REMODEL

- A. A device box shall be provided for each telecommunications outlet. Device boxes shall be 4"x4"x3-1/2" (where 2-1/4" is the depth of the box and 1-1/4" is the depth of the extension ring, with an overall depth of 3-1/2"). Device boxes shall be recess-mounted.
 - If Category 6A cabling will be used, the Designer shall require 5"x5" device boxes regardless of the cable count.
- B. Surface-mounted device boxes are not acceptable. However, for concrete masonry unit (CMU) walls or other wall types that may obstruct cable or conduit installation, the Designer shall request direction from the WSUS ITPM on a case-by-case basis.

4.5.1.2 FOR OTHER PROJECTS

- A. Existing device boxes and conduits shall be reused where they are standards-compliant or where it can be verified that the existing conduits and boxes will permit telecommunications cabling to be installed without negatively affecting the performance of the cabling. The bend radius of the cabling inside each box shall be considered carefully when evaluating existing boxes. For concealed conduits that cannot be verified, the Designer shall assist the WSUS ITPM to consider conduit length, number of bends and cable fill percentage, then decide whether they are suitable for reuse on a case-by-case basis.
- B. A device box shall be provided for each telecommunications outlet. Device boxes shall be recess-mounted wherever possible and shall be 4"x4" and at least 2 1/2" deep (a 3 1/2" depth is preferable). Surface-mounted device boxes (if required) may be standard single gang (2" x 4") and at least 2 1/2" deep.
- C. Where cabling can be fished through interstitial wall spaces, it is typically permissible to use faceplate mounting brackets in lieu of device boxes.

4.5.2 HORIZONTAL PATHWAY SYSTEMS

The process of selecting the type of pathway that would be appropriate for a particular project shall be a cooperative effort involving the Designer and the WSUS ITPM.

4.5.2.1 GENERAL PATHWAY DESIGN CONSIDERATIONS

- A. All cables shall be fully supported and properly transitioned throughout the length of the cables, including proper bend radius fittings at pathway transitions. Where cabling is routed vertically, it shall be appropriately secured such that the weight

of the cabling does not subject the cabling to stresses that could potentially reduce the performance of the cabling.

- B. The Designer shall discuss pathway type and size options with the WSUS ITPM.
 - 1. The Designer shall discuss the relative merits of the pathway options available and shall assist the WSUS ITPM and the project design team to select the most appropriate pathway solution for the project.
 - 2. The future growth anticipated for the facilities affected by the project shall be discussed. Horizontal feeder pathways (cable trays, conduits from TRs to distribution junction boxes) shall be sized to support the initial cabling installation plus a minimum of 25% growth.
 - 3. For new construction and full remodel projects, J-hook pathways are not permitted. For other projects, J-hook pathways shall be sized to support 100% additional cables after the original cabling installation. In other words, the pathway shall be no more than 50% full after installation is completed.
- C. Spare pathway shall be designed to terminate at building perimeters where future expansion of the building is anticipated.
- D. When considering the design of a ceiling-located cable tray or J-hook pathway, the Designer shall verify that the pathway locations will comply with accessibility and clearance requirements. Cable tray and J-hook pathways routed through ceiling spaces shall be designed such that all installed cable is conveniently accessible after construction for both cable maintenance and to install subsequent cable additions. J-hooks shall be installed at approximate intervals of 4 to 5 feet. Conduit shall be used to span inaccessible areas where the pathway will cross “hard-lid” ceilings, where ceiling tiles are not readily removable, or where accessibility is impeded.
- E. Pathway routing shall remain on the same floor as the telecommunications room and telecommunications outlets served by the pathways. Where project-specific conditions exist that justify other routing, the Designer shall request WSUS approval through the SVR process.
- F. “Poke-thru” penetrations to the ceiling space of the floor below are normally not permitted. For minor remodel construction, poke-thru penetrations may be allowed given budgetary, project size, or other limiting factors. Permission to use poke-thru pathways in any circumstance requires an SVR on a project-by-project basis, and always requires the services of a structural engineer to avoid irreparable structural damage.
- G. All wall and floor penetrations for cabling shall be fully sleeved with bushings and protected in accordance with the requirements in the International Building Code.
- H. For on-grade slab construction, telecommunications conduits shall not be routed in or under the slab (a designated wet environment) unless no other options exist.

- Floor boxes under conference tables in Meeting Rooms and under instructor podiums in Classrooms are granted exception to this requirement.
- In any application (including Meeting Rooms and Classrooms) where telecommunications conduit passes in or under an on-grade slab, outdoor-rated cabling shall be provided.

4.5.2.2 PATHWAYS FOR NEW CONSTRUCTION AND MODERNIZATION PROJECTS

- A. Where ceiling spaces will be inaccessible after construction, the only permitted pathway option is conduit. J-hook pathway systems, cable tray and wire basket are not permitted if ceiling spaces will be difficult to access after construction.
- B. Surface raceways and surface-mounted device boxes are not permitted.

4.5.2.3 PATHWAYS FOR MINOR REMODEL AND TELECOMMUNICATIONS-ONLY PROJECTS

- A. For minor remodel construction, there may not be an existing (or suitable space for a new) telecommunications room available on the same floor as an outlet. While pathways shall generally be designed from the device box serving the telecommunications outlet to the nearest telecommunications room on the same floor as the outlet, this requirement may be waived at the discretion of the WSUS ITPM.
- B. Existing pathways shall be reused where existing raceway is standards-compliant or where it can be verified that the existing pathway will permit telecommunications cabling to be installed without negatively affecting the performance of the cabling. Where a pathway is concealed or cannot otherwise be verified, the Designer shall request direction from the WSUS ITPM on a case-by-case basis.
- C. Where existing pathways cannot be reused, or where additional pathways are required:
 - 1. J-hook pathway may be used. D-ring and bridal-ring pathways are not permitted. J-hook pathways shall be established through concealed spaces. J-hook pathways shall be sized for a minimum of 100% expansion. In other words, the pathway shall be no more than 50% full after installation is completed.
 - 2. When 40 or more cables are designed to be routed through an area, the use of cable tray or conduit shall be considered in lieu of J-hooks.
- D. It may be permissible to use faceplate mounting brackets in lieu of device boxes. In these cases, cabling is routed to the outlet location through interstitial wall spaces. WSUS permission for this method is required on a project-by-project basis.

4.5.2.4 CABLE TRAY PATHWAY SYSTEMS

- A. In general, cable tray systems shall be located in corridor or office throughway spaces, and shall not be installed above office or classroom space. Distances from EMI/RFI sources shall be maintained according to Section 4.2, *Electromagnetic Compatibility* (above), regardless of whether the raceway is routing copper- or fiber-optic based media.
- B. Projects designed using cable tray may use welded-wire type trays in locations concealed in the ceiling.
- C. Where it is not possible to conceal cable trays, the design shall specify aesthetically finished cable trays that conceal the cabling from below.
 - Steel cable tray is preferred over aluminum because aluminum is much easier to dent and deform, either inadvertently or through careless handling.
 - WSUS prefers a galvanized finish, painted to match its surroundings to minimize the presence of the tray.
- D. Wall-mounting is preferred for cable tray because it provides unrestricted access to the side of the cable tray.
 - Center-hung mounting is preferred over trapeze-style hangers when wall-mounting is not practical.
- E. The Designer shall coordinate the selection of the cable tray materials with the design intent of the Architect or interior designer.
- F. Telecommunications cable trays shall not be shared with power cables.
- G. Conduit used to route cabling from the cable tray to the work area outlet shall be sized a minimum of 1".
- H. Ladder racking shall be used only in telecommunications rooms. It shall not be used anywhere else.
- I. Spine-style tray is not acceptable.
- J. Wherever possible, WSUS prefers that cable trays be routed through non-plenum spaces, so that non-plenum-rated cabling can be used.

4.5.2.5 CONDUIT AND JUNCTION BOX PATHWAY SYSTEMS

- A. Conduits both in and under the ground floor slab are considered "wet locations" where indoor-rated cabling is not permitted. Therefore, conduit serving the main floors of such buildings shall be routed in walls and ceilings – not in or under the slab. Intra-building and horizontal pathways shall only be installed in "dry" locations where indoor cabling can be protected from humidity levels and condensation that are beyond the intended range of indoor-only rated cable.
 - Floor boxes in an on-grade slab are the only permissible exception. This application also requires outdoor-rated Category 6 cabling.

- B. Where conduit runs terminate at cable trays, the conduits shall be arranged in an organized, uniform manner to facilitate an orderly cable transition from conduit to cable tray. Conduits shall terminate within a range of 3" to 18" of the cable tray.
- C. Where conduit runs terminate in telecommunications rooms, the conduits shall be arranged in an organized, uniform manner to facilitate an orderly cable transition from conduit to ladder rack.
- D. Non-metallic conduit and flex conduit shall not be used for horizontal pathways.
- E. Conduits shall not be filled beyond 40%. The Designer shall verify the outer diameter of the cabling for a project at the time of the design to determine the maximum number of cables that can be placed inside a conduit without exceeding the 40% fill limitation.
- F. In new construction, all work area outlets shall have a minimum 1" conduit routing from the device box to an accessible cable pulling location. The conduit size shall be increased as necessary for the quantity of cables to be installed. Where new conduit is installed in existing buildings, the Designer shall notify WSUS when existing conditions prevent the use of 1" trade size conduit as a minimum conduit size.
- G. Device boxes shall not be "daisy-chained." Each device box shall be complete with its own dedicated conduit to the nearest distribution point/pathway.
- H. Junction boxes and pull boxes shall be oriented for access doors to open from the area where the cable installer will normally work. For ceiling-mounted boxes, this is typically from the bottom (floor) side of the box.
- I. Ceiling access to junction boxes and pull boxes shall be designed to allow full access to the door, adequate working room for installation personnel, and proper looping of the cable during installation.
- J. Junction boxes and pull boxes shall be located in spaces that are easily accessible during normal working hours, such as hallways and common areas. Junction boxes and pull boxes shall not be located in conference rooms or offices unless there is an overriding design reason for doing so, dependent upon approval from WSUS.

4.5.2.6 SURFACE RACEWAY

- A. Surface raceway may be permissible in areas where no suitable alternatives exist. Surface raceway shall conform to bend radius requirements for the cable type being installed.
- B. Surface raceway may be either plastic or metal.

- C. For projects using Category 6A (Augmented) cabling routed through surface raceway, the Designer shall verify cable dimensions and bend radius limitations with the cable manufacturer to determine whether the surface raceway will be deep enough. Typically only two jacks will fit in a faceplate, and the jacks must be side-entry style in order to meet cable bend radius requirements.

4.5.2.7 UNDERFLOOR DUCT SYSTEMS

- A. The design of new underfloor duct systems is discouraged. Some existing buildings have existing underfloor duct systems, and as long as the existing ducts are suitable for use with new cabling, it is permitted.

4.5.2.8 ACCESS FLOORS

- A. Data Centers typically require access flooring.
- B. While some open office circumstances may require access flooring, it may be more expensive than other pathway options. When considering solutions to provide cabling in open office situations, the Designer shall consider other solutions (such as floor boxes) ahead of an access flooring solution.

4.5.3 HORIZONTAL CABLING SYSTEMS

4.5.3.1 GENERAL

- A. The Designer shall work with the WSUS FSPM and the WSUS ITPM to identify and understand the needs and requirements for the facility on a project-by-project basis. This includes understanding the expected future uses of the facility. The Designer shall design the horizontal cabling accordingly.
- B. Telecommunications infrastructure designs and specifications shall be based upon products from the required manufacturers, as defined in TDDG Section 1.5 Required Manufacturers (above).
- C. Wherever permissible, WSUS prefers to use cabling that is *not* plenum-rated due to the high cost of plenum-rated cabling.
- D. In addition to the manufacturers listed above, WSUS has selected several manufacturers of products for telecommunications cabling systems (cable, connectors, termination blocks, patch panels, etc.) and telecommunications distribution hardware (racks, cable tray, enclosures, etc.). The Designer shall incorporate only these manufacturers into the design, and shall design a telecommunications distribution system that will be suitable for the use of products from these manufacturers.
- E. Splitting of wire pairs degrades the performance of the cable pairs and voids the manufacturer's warranty.

1. Under no circumstances shall cable pairs be split or removed from the back of a modular jack or patch panel. All four pairs of each horizontal distribution cable must be terminated to a single 8-position, 8-conductor jack.
- F. Whenever moves, adds or changes (MAC) are made to existing systems, the new cabling shall follow the routes of existing established telecommunications cabling pathways.

4.5.3.2 TOPOLOGY

WSUS has standardized on the star topology for all horizontal cabling, with some exceptions for certain building automation systems that require or benefit greatly from ring or other topologies.

4.5.3.3 HORIZONTAL CABLE TO SUPPORT DATA APPLICATIONS

- A. At WSUS facilities, horizontal distribution copper cable and components for data applications shall be rated for and installed in compliance with the IEEE 802.3ab 1000Base-T Gigabit Ethernet standard. WSUS requires 4-pair, 100-ohm, 24 AWG, unshielded twisted-pair (UTP) copper Category 6-rated cabling for all horizontal cabling applications. The only exceptions to this are as follows:
- Data Center applications, where Category 6A cabling should be considered.
 - Where isolated applications require 10GB network bandwidth, use 50 micron multimode OM3 fiber optic cabling to a 10GB network switch and Category 6A patch cords from the switch to each device in the 10GB network.
 - Multimode Fiber Optic cable shall be used between floors. Single mode shall be used between buildings.
 - Where applications require larger quantities of cabling in non-isolated applications, Category 6A cabling shall be used.
- B. Horizontal cables shall be terminated at the work area end and patch panel end with modular jacks.
1. WSUS has standardized on the color white for horizontal cabling. The Designer shall inquire with WSUS whether cable color should be different for a given project.
 2. The Designer shall coordinate the modular jack color with WSUS and the Architect.
- C. In existing buildings, where additions are made to an existing Category 5 or 5e installation, the Designer shall seek direction from WSUS regarding whether to install Category 5e or Category 6 cabling. Typically, WSUS prefers to add more Category 5e cabling where the building is already cabled with Category 5e. On the other hand, if the building is cabled with Category 5 cabling, then Category 6

cabling shall be installed for all new outlets.

1. Category 5 cable and components shall not be installed under any scenario.
2. Category 5e or 6 cables shall be terminated at the work area end with a modular jack matching the category of the cabling.

4.5.3.4 HORIZONTAL CABLE TO SUPPORT VOICE APPLICATIONS

- A. WSUS uses VOIP for all new voice applications. Therefore, horizontal distribution cable intended to support voice services shall be the same Category 6 cable that is used for data applications. This cabling shall meet the same performance and test requirements as cabling intended for data applications.
- B. In existing buildings where Category 3 cabling currently serves voice applications for non-VOIP telephone systems, Category 6 cable shall be used when new voice cabling is installed. WSUS is in the process of converting all of its telephone systems to VOIP. Therefore, it is prudent to install Category 6 cabling even if analog telephones are being used.

4.5.3.5 LOW-VOLTAGE AND BUILDING AUTOMATION SYSTEMS

- A. During planning for intra-building telecommunications cabling installations, the Designer shall identify options for supporting power-limited (low-voltage) and building automation systems with the common structured cabling system, and present the options to WSUS for consideration. These options shall comply with ANSI/TIA/EIA 862 – Building Automation Systems Cabling Standard for Commercial Buildings.
- B. By providing a common cabling distribution system for the various building automation systems, it may be possible to reduce construction costs and operational costs while creating an intelligent building that can contribute many other benefits (see TDMM Chapter 16 *Building Automation Systems* for further information). Low-voltage systems that are capable of using a common structured cabling system (either backbone or horizontal cabling) shall be designed to use telecommunications cable and termination hardware wherever possible.
- C. The Designer shall request from WSUS a list of systems that will require telecommunications outlets for operations. The Designer shall then include horizontal cabling in the design as necessary to meet the listed requirements.
- D. Some low-voltage and building automation equipment benefit from installing a connector directly onto the horizontal cable without first terminating it in a jack.
 - One significant uniqueness for Category 6 telecommunications cabling intended for use with permanently-mounted equipment is detailed in the new standard ANSI/BICSI D005 - *Electronic Safety and Security (ESS) Information Technology System (ITS) Design and Implementation Best Practices*.

- This standard permits Category 6 cabling to be terminated on the device end of the cable using a connector (as opposed to a jack) allowing the horizontal cable to plug straight into the device.
 - The Category 6 horizontal cable does not need to terminate in a faceplate-mounted jack.
- E. Other low-voltage and building automation equipment use terminals that require the cable to be terminated directly onto the equipment without using a modular jack. There is no method of testing a cable in this configuration.
 - This application is not standards compliant, and is unlikely to be approved by the ITPM.
 - In most cases, it is possible to terminate the horizontal cable in a standard outlet inside a panel, field manufacture a half-patch cord to plug into the outlet, and then terminate the raw end of the half-patch cord directly onto the terminals of the equipment.

4.5.3.6 HORIZONTAL CROSS-CONNECT (HC)

WSUS has standardized on angled patch panels for terminating all copper horizontal telecommunications media, regardless of the intended use of the horizontal cabling, including cabling that will be used for voice, data, video or building automation systems.

4.5.3.7 PATCH CORDS

- A. Patch cords shall be factory-manufactured patch cords. Patch cords shall be certified by the manufacturer to match the cable type used in the horizontal distribution.
 - 1. Category 5E patch cords are only permitted for use with Category 5E horizontal cabling applications.
 - 2. Category 6 patch cords are permitted for use with both Category 5E and Category 6 horizontal cabling applications.
 - 3. For Category 6A applications, Category 6A patch cords shall be used.
 - 4. Patch cords shall be factory-manufactured by the SCS manufacturer. Field-connectorized patch cords are not acceptable. Any existing field-connectorized patch cords used in areas affected by a project shall be replaced under the project with factory-manufactured patch cords.
- B. Patch cords in the telecommunication rooms shall be black in color.
- C. The Designer shall quantify and specify the required patch cords in the Contract Documents to be provided by the Contractor for each particular project, as shown in Table 4.1, below:

Table 4.1 Patch Cord Requirements

Applications	Patch Cord Quantities	Length
Work Area (Outlet end)	Typically require CAT6 patch cords to be furnished by the Contractor for each outlet port	For each application with a known length, provide a patch cord length that will reach the

	plus 10% spare. This shall be confirmed with the WSUS ITPM on a case-by-case basis.	equipment plus 6ft to 10ft additional length. Otherwise, provide a 10ft patch cord.
Telecom Room (Patch Panel end)	Typically require CAT6 patch cords to be furnished by the Contractor for each patch panel port plus 10% spare. This shall be confirmed with the WSUS ITPM on a case-by-case basis.	Provide patch cords in lengths sufficient to reach between patch panels and network switches. Patch cords shall also be long enough to permit future repatching without excessive slack.

- D. The Owner will install all patch cords. This includes routing patch cords through modular furniture, connecting to telephones, and also the patch panel-to-switch connections in the telecommunications rooms.

4.5.3.8 PHYSICAL SEPARATION REQUIREMENTS

There are currently no WSUS-driven applications or policies that require certain cables to be physically segregated from other cables. The only expected source of such a requirement would come from a regulatory authority. The Designer shall consider whether any such regulations exist when designing cabling applications for WSUS.

4.6 Backbone Distribution Systems

Please refer to Chapter 6, *Backbone Distribution Systems* in the BICSI TDM, Chapter 5, *Cabling Infrastructure* and Chapter 6, *Pathways and Spaces* in the BICSI OSPDRM, and Chapter 2, *Pathways and Spaces* in the BICSI ITSIMM for general information regarding the design of backbone distribution pathway and cabling. The following requirements take precedence over the guidelines in those documents for telecommunications infrastructure at WSUS facilities:

4.6.1 INTRA-BUILDING BACKBONE PATHWAYS

- A. Intra-building backbone pathway shall utilize a physical star topology. The Designer, however, shall inquire whether another pathway topology would be appropriate for a given application. Backbone raceway shall consist of conduit, chases or shafts, sleeves, and/or vertically-mounted ladder racking.
- B. All cables shall be fully supported and properly transitioned throughout the length of the cables, including proper bend radius fittings at pathway transitions. Where cabling is routed vertically, it shall be appropriately secured such that the weight of the cabling does not subject the cabling to stresses that could potentially reduce the performance of the cabling.
- C. In new construction and remodel projects:
 1. The main telecommunications room in the building shall have a direct pathway connection to the entrance facility.
 2. All intermediate telecommunications rooms shall have direct pathway connections to the main telecommunications room in the building.
 - This is usually accomplished with vertical riser pathway (STI EzPath).

3. For buildings requiring multiple intermediate telecommunications rooms on a given floor, the secondary telecommunications rooms do not require a direct backbone pathway to the main telecommunications room. Instead, the first intermediate telecommunications room on a floor shall have a direct pathway and the other telecommunications rooms shall connect to the first via the main cable tray on that floor.
 - This solution is typically adequate when backbone cables are relatively small compared to the horizontal cable load in the cable tray.
 - Even though **pathway** from one telecommunications room may connect to another telecommunications room before connecting to the main telecommunications room, backbone **cabling** shall not cross-connect in the interposing telecommunications room. Intra-building backbone cabling shall be continuous (non-spliced) between the main telecommunications room and each intermediate telecommunications room.

4.6.1.1 BACKBONE RACEWAY SIZE AND QUANTITY REQUIREMENTS

- A. Future growth requirements shall be considered when sizing intra-building backbone pathways. The cost to install additional spare pathways during initial construction is significantly less than the cost of retrofitting additional pathway in the future.
- B. In general, for new construction and modernization projects, WSUS requires a minimum of four 4" EzPath sleeves leaving the main telecommunications room/entrance facility enroute to the intermediate telecommunications rooms on floors above. However, for buildings higher than five floors, additional EzPath sleeves shall be provided.

4.6.1.1.1 SINGLE-STORY BUILDINGS

- A. For single-story buildings with multiple telecommunications rooms, 4" conduit pathways shall be routed through the ceiling, not in or under the floor slab. The Designer shall determine the number of 4" conduits required to serve initial and future backbone cabling requirements.
 1. In cases where it is not possible to route 4" conduits to each of the telecommunications rooms, three 2" conduits may be substituted for each required 4" conduit.

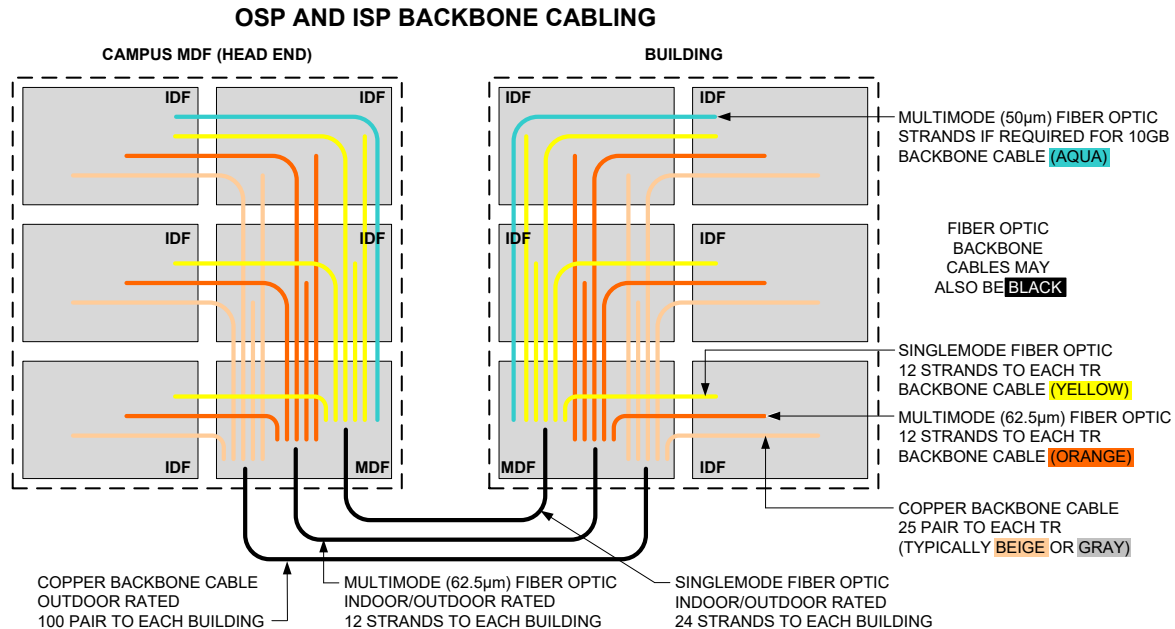
4.6.1.1.2 MULTI-STORY BUILDINGS

- A. In new construction and modernization projects, telecommunications rooms shall be vertically aligned (stacked) floor-to-floor wherever possible. Sleeved vertical pathways shall be extended to the roof (or to an attic space with access to the roof) to facilitate access for future roof or side-of-building mounted antennas or other telecommunications equipment.
- B. Ladder racking shall be vertically-mounted in the stacked telecommunications

rooms to route and support backbone cable passing from the room below to upper rooms.

4.6.2 INTRA-BUILDING BACKBONE CABLING

The diagram below depicts intra-building and inter-building backbone cabling requirements (including strand and pair counts) for WSUS buildings:



4.6.2.1 INTRA-BUILDING BACKBONE CABLE TYPES

- A. WSUS uses three types of telecommunications cabling for intra-building backbone systems:
 - Multipair copper voice backbone cable
 - 8/125µm OS2 Singlemode fiber optic cabling (yellow color)
 - 62.5/125µm OM1 Multimode fiber optic cabling (orange color)
- B. On the rare occasion that a floor-to-floor application requires 10GB communications, WSUS uses:
 - 50/125µm OM3 Multimode fiber optic cabling (aqua color)
- C. Splices are prohibited for backbone cabling.

4.6.2.2 STRAND AND PAIR COUNTS

- A. The diagram above indicates all standard strand and pair counts.
- B. Backbone cable sizing (# of strands, # of pairs) shall be considered with respect to possible future requirements. The cost to add additional backbone pairs and

strands during the initial installation is significantly less than the cost of adding another cable in the future.

The Designer shall inquire whether 40GB or 100GB backbone bandwidths are required. These bandwidths require multiple strands for each circuit.

- C. The minimum number of fiber optic strands to be provided shall be equal to 2 strands per piece of equipment being hosted in the telecommunications room that requires a circuit, plus one hundred percent expansion capability.
- D. Each telecommunications room shall be served with a minimum of a 25-pair copper voice backbone cable.
- E. WSUS permits appropriate use of hybrid singlemode/multimode fiber optic cabling, and allows both types of fiber to be terminated on separate bulkheads in a single fiber optic patch panel.

4.6.2.3 CABLE SEGREGATION

In no case shall copper or fiber optic backbone cabling be run in the same raceways as those used by electrical power conductors. However copper, fiber optic and other low-voltage cables are permitted to run together in shared raceways.

4.6.2.4 INNERDUCT

Innerduct is required for WSUS facilities.

4.6.3 INTER-BUILDING (CAMPUS) BACKBONE PATHWAYS

The Designer shall follow the guidelines in the BICSI TDMM and the BICSI OSPDRM when designing underground outside plant pathways.

4.6.3.1 DUCTBANK

4.6.3.1.1 CONDUIT TYPES

- A. WSUS requires 4" Schedule 40 PVC for all outside plant pathway except ducts serving Blue Light Emergency Telephones which shall be trade-size 1½" conduit.
- B. OSP conduit shall transition from PVC to PVC-coated rigid steel conduit when it enters within 10-feet of the building foundation and shall route from that point to the building entrance facility. PVC-coated, rigid steel conduit is intended to defend against the shearing effects of differential ground settling around the building foundation. It also increases the protection against future landscaping activities near the building.

- Transition back to PVC conduit after passing five feet inside the building foundation is acceptable as long as the conduit remains in or under the slab, otherwise it shall transition to rigid galvanized steel conduit.
 - A maximum of fifty feet of outdoor-rated cable is permitted in a building space. Therefore, rigid galvanized steel conduit shall be used to route the cable until it is close enough to its termination point that fifty feet or less outdoor-rated cable (including slack loops) will be exposed.
- C. The use of flexible metallic conduit and flexible non-metallic conduit is prohibited.

4.6.3.1.2 BURIAL DEPTH AND SLOPE

- A. The preferred ductbank depth is 36" to the top of the conduit. Where this is unattainable, a 30" depth is permitted.
- Under no circumstances will ductbanks ever be permitted shallower than the extent of the frost zone. In Spokane, the frost zone reaches 24" below the surface, according to Spokane County⁴.
- B. Conduit to be used for routing entrance cables from third party service providers to an entrance facility shall be installed per the service providers' requirements, generally 36 to 48 inches deep. The Designer shall consult with the service providers prior to designing conduits serving an entrance facility.
- C. A continuous drain slope should exist at all points along the ductbank to allow drainage and prevent the accumulation of water.
- A drain slope of 1/4" per foot is desirable where possible.
 - Where 1/4" per foot is not possible due to inadequate natural slope or long duct runs, a drain slope of no less than 1/8" per foot is acceptable.
 - If no other option exists, require the Contractor to provide a "center crown" drain slope by sloping the first half of the ductbank up towards the midpoint, and then down from the midpoint to the end. Of course, the center crown technique cannot be used for conduits between a maintenance hole and a building, because water would then drain into the building.

4.6.3.1.3 CONDUIT SWEEPS (BENDS)

- A. WSUS has standardized on the use of factory-manufactured fiberglass sweeps with a minimum bend radius of 48" for all OSP ductbanks with the following exceptions and alternatives:
- Shallow curves comprised of continuous lengths of individual straight RNC conduit are permissible with a minimum sweep radius of 40 feet.
 - Where cabling larger than 400-PR UTP copper is intended to be installed, conduit bends shall have a radius larger than 48". The Designer shall consult with the WSUS ITPM on a case-by-case basis to select appropriately-sized conduit sweeps.

⁴ <http://www.spokanecounty.org/bp/content.aspx?c=2320>

- B. The Designer shall minimize the effects of sidewall pressure between the cable and conduit at bend points where possible by designing bends with the tightest bend radii to be near the cable feed end of the duct section rather than the middle or end of the duct bank.

4.6.3.1.4 DUCTBANK ENCASEMENT

WSUS requires concrete encasement with full-length reinforcement and formed sides for all ductbanks except ducts serving Blue Light Emergency Telephones which shall *not* be encased in concrete.

- A. Prior to concrete being poured, the WSUS ITPM or a designated representative shall observe the OSP conduit installation to identify unacceptable installations that need to be corrected prior to concrete encasement.
- B. In general, direct-buried conduit ductbanks are not permissible, unless extenuating circumstances warrant and this is approved by WSUS through the SVR process. Should the use of direct-buried conduit ductbank be warranted, the Designer shall ensure that all bends in the ductbanks are encased in concrete.
- C. Wherever cold-joints are required in concrete encasement, the design shall require rebar spanning the joint between ductbank encasement segments.

4.6.3.1.5 NUMBER OF DUCTS

- A. The OSP pathway system shall accommodate the requirements for signal and low-voltage cabling systems at WSUS facilities. The Designer shall inquire with the WSUS ITPM and FSPM about the potential for future buildings or building expansions that may adversely affect an existing or proposed distribution pathway and accommodate those plans within the design.
- B. The number of 4" conduits in a ductbank should meet the needs of the specific application and should offer future expansion capability. The following list is a guideline for consideration when designing a new ductbank.
- Small utility buildings up to 5,000 sq. ft.: 2 ducts (approvable on a case-by-case basis)
 - Buildings up to 100,000 sq. ft.: 4 ducts
 - Buildings 100,000 sq. ft. to 300,000 sq. ft.: 6 ducts
 - Buildings larger than 300,000 sq. ft.: multiple redundant entrances with 6 ducts each
 - Buildings serving as a data center or communications center: 6 ducts

4.6.3.1.6 DUCTBANK LENGTH

- A. In general, ductbank systems shall be designed with section lengths averaging 400 feet and as straight as possible.

- B. The maximum permissible ductbank length (between maintenance holes and/or buildings) is 600 ft. Ductbank runs that exceed this distance require intermediate maintenance holes or handholes. This requirement may be waived through the SVR process in rare cases having the following conditions:
- The ductbank run has no bends.
 - The Designer can demonstrate that the pulling tension of WSUS' standard OSP telecommunications cable types will not be exceeded during installation.

4.6.3.1.7 SEPARATION FROM OTHER UTILITIES

- A. In general, ductbank used as pathway for telecommunications and other low-voltage cabling should not be routed with other utilities. Budgetary constraints, space limitations, and various obstructions can make this difficult to achieve at times. Should shared routing be a necessity (perhaps for overbuild construction projects), the Designer shall ensure that adequate separation exists between ducts used for telecommunications and ducts used for other utilities.
- B. The pathway system shall be designed such that telecommunications and other low-voltage systems do not share conduits, maintenance holes, handholes or tunnels with the electrical power distribution system. The telecommunications distribution pathway shall also maintain minimum separation distances from electrical power distribution infrastructure as required by WSUS.

The vertical and horizontal separation requirements for OSP telecommunications pathways from other underground utility infrastructure are as follows:

4.6.3.1.7.1 Proximity to Power or Other Foreign Conduits

NESC requirements state that outside plant telecommunications conduits shall not be installed closer to power conduits or other unidentified underground conduits than:

- 3" where the surrounding material is concrete
- 4" where the surrounding material is masonry
- 12" where the surrounding material is well-tamped earth

The NESC requirements above are focused on safety issues, and the performance of telecommunications systems can be negatively affected by the presence of nearby sources of EMI, even though the NESC safety-related separation requirements are met. Where the Designer is concerned about EMI due to the proximity of power distribution infrastructure, the Designer shall discuss the issue with the WSUS ITPM.

4.6.3.1.7.2 Proximity to Water, Gas or Oil Conduits

Outside plant telecommunications conduits shall not be installed closer to conduits that can be identified as not containing electrical power distribution conductors than:

- 6" where the conduits cross
- 12" where the conduits run parallel to each other

Telecommunications conduits running parallel to water, gas or oil conduits shall not be installed vertically above the other conduits, but rather to the side of the conduits. This arrangement should contribute to decreased disruption to the telecommunications conduits in the event of excavation maintenance activities associated with the other nearby conduits.

4.6.3.1.7.3 Proximity to Steam Lines and Steam Utilidors

- A. A minimum separation distance of 12" is required between a steam utilidor and telecommunications conduits.
- B. Steam lines pose two primary risks to telecommunications cabling:
 - Under steady state operating conditions, objects in the vicinity of steam lines may warm due to heat lost through the insulation of the steam line. As the temperature of telecommunications cabling increases, its performance can degrade. In situations where there is concern about the risk of exposure to steady state heat, the separation distance between the steam line and telecommunications infrastructure shall be increased.
 - In the event of a steam line failure in the proximity of telecommunications infrastructure, significant damage to the conduits and cabling can result from the high temperature steam. In situations where there is concern about the risk of exposure to high temperatures from steam line failure events, the design shall require telecommunications conduits to be encased within an insulating sleeve in the vicinity of the risk.
- C. High-temperature insulation may be necessary to protect telecommunications conduits and cabling.
- D. WSUS' practice is to install steam lines in utilidors, rather than to direct-bury the steam lines. The utilidors are typically 3 to 4 feet high, and may be buried with 0 to 2 feet of surface cover. Therefore, the bottom of most utilidors on campus is typically somewhere between 3 and 6 feet deep.
- E. The Designer shall field-investigate the actual utilidor routing to identify accurate field conditions. Potholing to confirm record drawing information is typically required.
- F. Where physical conditions appear to preclude compliance with the following requirements, an SVR shall be submitted demonstrating solutions for mitigating exposure to worst-case conditions, including steam line failure where steam vents in the direction of the telecommunications conduits.

4.6.3.1.7.3.1 Crossing Above Steam Utilidors

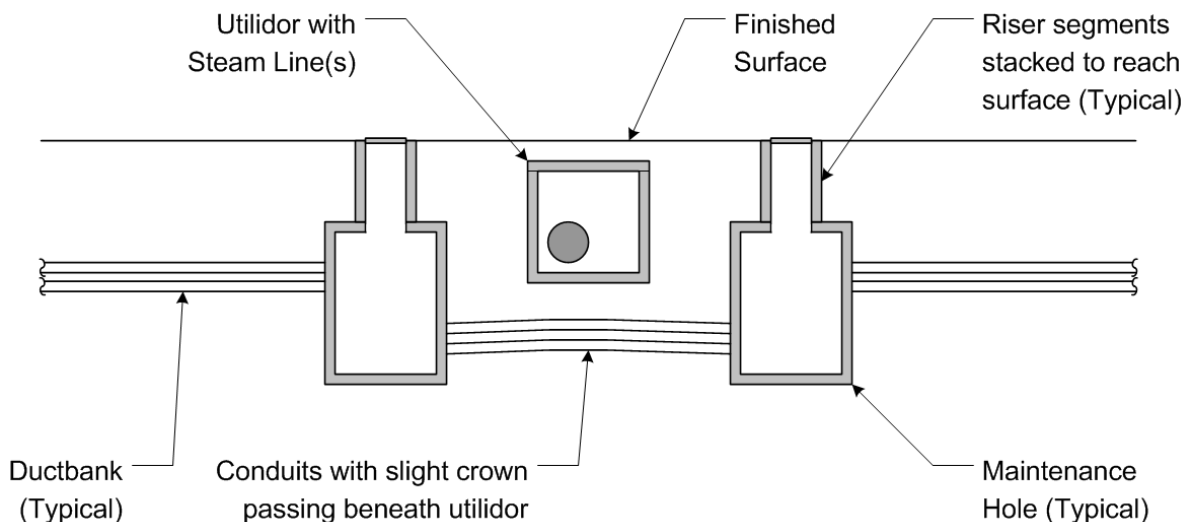
- A. Due to the requirement to bury conduit beneath the frost line, a cover depth of 50 inches is required for a topside conduit crossing. Unless a utilidor has at least this much topside cover, it will not be possible to install a single-level conduit

ductbank over the top of the utilidor while maintaining 12" separation from the top of the utilidor and while keeping the conduit below the frost line.

- It is unlikely that a circumstance permitting a topside crossing will occur at WSUS.
- B. Telecommunications ductbanks shall not cross over the top of a steam utilidor in a live load area where vehicle traffic passes without the review of a Civil Engineer.

4.6.3.1.7.3.2 Crossing Beneath Steam Utilidors

- A. Most commonly, where telecommunications conduits must cross a steam utilidor, the conduits must cross underneath the utilidor. Care shall be taken to avoid creating a dip in the conduit at this point where water will collect – the conduit slope shall be designed to permit any water entering the conduits to drain out. The following diagram depicts this concept:



- B. The Designer shall design a utilidor crossing similar to the pre-approved solution shown in the diagram above, or some other solution that accomplishes a utilidor crossing without trapped water and without risking cable damage due to nearby steam heat. The Designer shall include details of any steam utilidor crossings in the Construction Documents.

4.6.3.1.7.3.3 Direct Buried Steam Lines

- A. If it becomes necessary to install telecommunications conduits in the vicinity of direct-buried steam lines, the following requirements apply:
- Telecommunications conduits shall not be installed closer than 12 inches to steam lines, and shall cross perpendicular to the steam lines.
 - Direct-buried steam lines within 12 to 24 inches of telecommunications conduits shall be encased within an insulated pipe sleeve surrounding the

steam line. The sleeve shall be constructed from a material designed to withstand steam temperatures and protect against physical/mechanical damage from jets of steam. The insulated sleeve shall extend at least 5 feet on both sides of the crossing point of the telecommunications conduits.

4.6.3.1.8 INNERDUCT

- A. WSUS requires the use of innerduct for all fiber optic cabling.

4.6.3.1.9 COORDINATION WITH UTILITY SERVICE PROVIDERS

The Designer shall inquire with the WSUS ITPM to determine whether services from utility service providers will be necessary. If so, the Designer shall contact the utilities to obtain their entrance pathway, entrance facility and demarcation point requirements.

4.6.3.2 MAINTENANCE HOLES AND HANDHOLES

- A. Typically, maintenance holes are installed for main ductbanks (i.e. ductbanks used for routing large portions of the telecommunications system backbone), and handholes/pullholes are installed for subsidiary ductbanks (i.e. ductbanks serving a single small building).
- B. Maintenance holes and their covers shall be appropriately sized for the application.
- Covers for maintenance holes and handholes shall be either lockable or use bolts to prevent unauthorized access.
 - Diamond plate hinged covers and removable diamond plate covers are not permitted for maintenance holes at WSUS.
- C. Telecommunications maintenance holes and handholes shall not be shared with electrical power distribution infrastructure. In general, powered devices should not be located in telecommunications maintenance holes and handholes.
- D. The number of duct entrances in a maintenance hole or handhole should be sized for both immediate and future requirements. Also, splayed duct entrance arrangements are preferred over center entrances.
- It is desirable to have ducts enter and exit from opposite ends of a maintenance hole or handhole. Sidewall duct entrances should be avoided because such entrances may obstruct racking space, cause cable bends to exceed limits, interfere with cable maintenance activities, and increase construction costs during cable installation.
 - WSUS recognizes that sidewall duct entry may be necessary or desirable in some circumstances. In these cases, sidewall ducts shall enter and exit at diagonally opposite corners – ducts shall not enter and exit at the midpoints of the endwalls or sidewalls. The Designer shall ensure that endwall and sidewall duct entry in a maintenance hole or handhole will not hinder access

to the maintenance hole or the proper installation and maintenance of cabling.

- E. Ducts shall be designed to enter the maintenance holes and handholes starting at the lowest conduit knockouts and moving upward, preserving remaining knockouts accessible for future conduit additions. The Designer shall design the duct entrances such that the relative position of each duct does not change as it enters and exits the maintenance hole or handhole. Also, the Designer shall endeavor to design ductbank arrangements so that the conduits enter and exit a sequence of maintenance holes or handholes in the same relative positions.
- F. Splices in backbone fiber optic cable are not allowed, and while splices in backbone copper cable may be permitted in some rare cases (through an approved ADR), they are discouraged. However, when sizing OSP telecommunications maintenance holes, the design shall require the Contractor to provide space for possible future splice closures when required (for example, to repair cable breaks).
- G. Some situations may require placement of maintenance holes at below-typical depths. In such cases, the top of the maintenance hole shall be placed at normal depth and the height of maintenance hole shall be increased through the use of intermediate riser extensions between the base and the top. WSUS wishes to avoid deep-collar entrance portals wherever possible, to improve lighting and ventilation.

4.6.3.3 AERIAL DISTRIBUTION

Aerial distribution of telecommunications cabling at WSUS facilities is not authorized. If an application requires aerial distribution, permission to use this method shall be requested through the SVR process.

4.6.3.4 BRIDGE AND WATERWAY CROSSINGS

A Civil Engineer shall review the construction of bridge and waterway crossing distribution systems. The design and installation shall also be reviewed by the WSUS ITPM.

4.6.3.5 WIRELESS AND RADIO SYSTEM DISTRIBUTION

- A. WSUS facilities use wireless or radio systems for telecommunications with mobile units and personnel, both on and off campus. These systems typically use one or more radio antennas connected by cabling to radio transceiver equipment. In some cases, the radio equipment may be interfaced into the telephone system. The outside plant telecommunications substructure shall be designed with adequate cable routing pathways between antenna locations, radio transceiver locations, and the telephone backbone cabling system.
- B. Radio antenna transmission cables that connect the antenna to the radio transceiver emit radio frequency (RF) radiation. These cables may be routed through the common telecommunications ductbank and maintenance hole

system if necessary, but shall be routed in a separate conduit from non-fiber optic telecommunications cables. Cables containing RF radiation shall be shielded cables.

- C. Radio interconnection cables (for analog or digital signaling to remote radio operating positions or to the telephone system) typically emit low levels of radio frequency radiation. These interconnection cables shall be routed through the common telecommunications ductbank and maintenance hole system. Individual conduits may be shared for these interconnection cables and other telecommunications services, and available cable pairs in telephone backbone cables may be used for these interconnections, provided that the signaling is analog or digital signaling, and is not direct radio frequency signal.
- D. WSUS facilities frequently use rooftop satellite, wireless or radio systems. These systems typically use one or more radio antennas connected by cabling to radio transceiver equipment. Pathways shall be designed from rooftop locations down to the main telecommunications room to serve these applications.

4.6.4 CAMPUS CABLING

When OSP cabling is required, the Designer shall follow the guidelines in the BICSI TDMM and the BICSI OSPDRM.

- A. The design shall require that a slack loop be installed inside the nearest maintenance hole or handhole (not stored in the TR). The Designer shall require that sufficient racking hardware be provided in the maintenance hole or handhole to support the slack loop.
- B. The length of the loop shall be a minimum of 25 feet. The Designer shall consider the arrangement of the telecommunications room and the possibility of a rearrangement that might consume the cable slack. If necessary, additional slack shall be required in the design, up to the NEC limit of 50 feet of exposed OSP-rated cabling.

4.6.4.1 UTILITY SERVICES

At WSUS, telephone services, cable television services and Internet services are typically provided via campus infrastructure. The Designer shall request from the WSUS ITPM information about any needed telecommunications infrastructure to support the required services. The Designer shall also request similar information from the WSUS FSPM for requirements to support non-WSUS tenants of the building.

4.6.4.2 WIRELESS AND RADIO SYSTEM DISTRIBUTION

- A. Outdoor-rated backbone cabling shall be designed to serve rooftop satellite, wireless or other radio system applications. Lightning protection equipment shall also be designed as appropriate.

- B. Radio antenna transmission cables that connect the antenna to the radio transceiver emit radio frequency (RF) radiation. These cables may be routed in a separate conduit from other telecommunications cables. Cables containing RF radiation shall be shielded cables.

4.7 Telecommunications Spaces

Please refer to Chapter 7, *Telecommunications Spaces* in the BICSI TDMM for general information regarding the design of telecommunications rooms. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

- A. In WSUS facilities, the TRs in a building may also serve as low-voltage systems equipment rooms, typically containing electronic equipment intended to serve the building or a portion of the building. The TR shall not be shared with electrical installations other than those necessary for telecommunications.

4.7.1 TELECOMMUNICATIONS ROOM LOCATION

- A. The Designer shall be responsible to inform the Architect of the sizing and location requirements for Telecommunications Rooms during the Schematic Design phase of the project.
- B. The most desirable location for telecommunications rooms shall be located as centrally and as closely as possible to the area being served. In addition, for multi-story buildings, telecommunications spaces shall be vertically aligned. This allows for clean, vertical pathway to be easily provided to each space. It also reduces the number of bends and offsets that the intra-building backbone pathway must undergo as it connects each of the telecommunications rooms. Please see the discussion in TDDG Section 4.6.1 Intra-building Backbone Pathways for further information.
- C. There shall be a minimum of one TR per building. Additional TRs shall be added when the area to be served exceeds 10,000 square feet or where the cable lengths will exceed 295 feet between a TR and the work area telecommunications outlet, including allowance for cable slack loops. Generally, each floor of a building shall be served by a TR located on that floor.
 - 1. When specifically approved by the WSUS ITPM, a TR may be designed to serve multiple floors of a building.
- D. Telecommunications Rooms shall not be co-located with any type of electrical room or mechanical room. The TR location shall maintain the separation distances identified in the Electromagnetic Compatibility (Section 4.2) of this document.
- E. The telecommunications room shall not be located in any of the locations listed below:

1. Areas subject to water or steam infiltration, particularly basements. Floor drains (with trap primers) are required if there is any risk of water entry.
2. Areas exposed to excessive heat or direct sunlight.
3. Areas exposed to corrosive atmospheric or environmental conditions.
4. Near or adjacent to potential sources of electromagnetic interference (EMI) or radio frequency interference (RFI) such as large electric motors, power transformers, arc welding equipment, or high-power radio transmitting antennas.
5. In a shared space with electrical equipment other than equipment serving the telecommunications system.

4.7.2 TELECOMMUNICATIONS ROOM SIZING

- A. Telecommunications rooms shall typically be one of the following three sizes (and larger where required):
- 6' x 8' for a one-rack application
 - 9' x 10' for a two-rack application
 - 12' x 10' for a three-rack application

Please note that the above room sizes are minimum dimensions, and are not representative of acceptable square footage allocations.

- For example, a 12'x10' space totals 120 square feet. A 5'x24' room would be an unacceptable space, even though it also totals 120 square feet.

See the sample telecommunications room plan drawings in Appendix 6.1 of the TDDG for further information.

- B. If project circumstances prevent the establishment of adequately-sized telecommunications spaces, the following options may be considered on a case-by-case basis, subject to the approval of WSUS:
1. Reach-in closets and small room designs for minor remodel construction projects may be considered through the SVR process.
 2. Wall-mounted swing cabinets are appropriate for some remodel applications serving small numbers of people and where floor space for a full telecommunications room would be unavailable or impractical.
 3. The Designer shall pay close attention to the requirements of the equipment that will reside in the cabinet and the space that will host the cabinet.
 - Don't undersize the cabinet – use cabinets that are 36" to 48" high.
 - Some applications require cabinets that are 30" deep and other applications will not permit cabinets that are more than 12" deep (with vertically-mounted electronics).
- C. Telecommunications room sizing shall be increased if other low-voltage systems equipment is intended to be hosted in the TR, for example fire alarm panels, security system equipment, etc. The Designer shall seek input from the WSUS ITPM regarding room sizing.
- D. Telecommunications rooms in new construction and modernization projects shall be sized such that ADA-required space is available after racks and equipment

have been installed.

4.7.3 ARCHITECTURAL PROVISIONING

- A. The Designer shall be responsible to inform the Architect of the architectural provisioning requirements for Telecommunications Rooms and to do this early in the Design Development phase of the project.
- B. The Designer shall be responsible to review project documents and determine that the architectural requirements for the telecommunications spaces are met as described in this document. For projects where an architect is involved, the Designer shall coordinate directly with the architect, and verify that the architect's design documentation meets these requirements. For projects without an architect, the Designer shall alert WSUS where additional architectural adjustments are needed to meet the requirements.
- C. Doors shall open out (180-degree swing) from telecommunications spaces wherever possible and shall be a minimum of 36" wide and 80" high, fitted with a lock. Coordinate lock and key requirements with WSUS. Doors shall be located in hallways or other common areas. Telecommunications room doors shall never be located in another building occupant's designated space.
 - The Designer shall inquire whether access control electronics are required for a given telecommunications room.
- D. Minimum clearance height within a telecommunications space shall be 8 feet. False ceilings (t-bar ceilings, ceiling grids, etc.) shall not be installed in telecommunications spaces. The floor, walls, and ceiling shall be sealed to reduce dust.
- E. Finishes shall be light in color to enhance room lighting. Flooring materials shall be light colored and slip resistant – carpet is not acceptable for telecommunications rooms. Interior floor finish and floor covering materials shall also meet the requirements in the International Building Code.
- F. The walls in telecommunications rooms shall be covered with plywood which has either been treated with fire retardant chemicals by a pressure impregnation process, or has been painted with a UL-listed, non-toxic fire retardant intumescent coating having a Class A surface flame spread rating. The plywood shall be painted with primer and two coats of white paint.
 - If an approved fire retardant intumescent coating is used, a small plaque shall be attached to the backboard near the door, listing the fire spread rating of the backboard, the manufacturer and the product number of the fire-retardant intumescent coating. This information may be helpful for future maintenance activities.

Plywood backboards shall extend from 6" above the floor up to a height of 8'6" above the finished floor.

4.7.4 ENVIRONMENTAL PROVISIONING

- A. The Designer shall be responsible to inform the Mechanical Engineer of the environmental provisioning requirements for Telecommunications Rooms and to do this early in the Design Development phase of the project.
- B. The Designer shall be responsible to determine that the mechanical HVAC requirements for the telecommunications spaces are met as described in this document. For projects where a Mechanical Engineer is involved, the Designer shall coordinate directly with the engineer, and verify that the engineer's design documentation meets these requirements. For projects without the involvement of a Mechanical Engineer, the Designer shall alert WSUS where adjustments to the mechanical infrastructure are needed to meet the requirements.
- C. The Designer shall coordinate with the Mechanical Engineer to ensure that the HVAC requirements for the telecommunications spaces are met and also that HVAC ductwork and motors do not conflict with cable tray or conduit routing.
- D. In addition to the requirements in the BICSI TDMM, telecommunications rooms shall be environmentally provisioned as follows:
 - 1. A fundamental design assumption is that all TRs will at some time contain active electronic equipment (hubs, routers, switches, etc.) even if the current design does not call for such devices. Network electronics require an HVAC system capable of operating on a 24 / 7 / 365 basis. If the building system cannot assure continuous cooling operation, a stand-alone cooling unit shall be provided for the TR.
 - This unit and any roof penetrations shall be located away from and not directly above electronics of any kind, to avoid damage from condensate drip and roof leaks.

In addition, a positive pressure differential with respect to surrounding areas is required to help keep dust and other particles out of the room.

- Where practical, the use of outside air for cooling is encouraged. Dehumidification and filtration may be required for systems using outdoor air.
- Where practical, WSUS encourages the use of heat reclamation features.
- Environmental management and monitoring systems shall be designed for TRs.
- Typically, the building's central air conditioning system should cool the telecommunications rooms during summer months. During the months when the central air conditioning system is not running, a stand-alone air conditioning system shall be used to cool the telecommunications rooms.
- Split systems are preferred, with the equipment located outside the TRs wherever possible. The temperature controls shall be located inside the telecommunications rooms.
- WSUS has an existing contract with Carrier for service. It would be

- convenient to have any new units also be from Carrier.
 - The heat load in some telecommunications rooms is small enough that simply exhausting the air is sufficient to maintain the temperature in the room. In these cases, positive pressure must still be maintained in the space to prevent the collection of dust.
2. WSUS typically provides network electronics that provide Power-over-Ethernet. The Designer shall request power consumption data for the equipment that WSUS will use, and work with the mechanical systems designer to ensure that the cooling capacity is sufficient to support the POE heat load.
 3. Minimum clearance height in the TR shall be eight feet without obstructions (light fixtures, ducting, etc.).
 4. The Designer shall carefully coordinate the location of fire suppression sprinklers and piping in telecommunications spaces.
 - If fire suppression sprinklers are required in telecommunication rooms, they shall be dual-action dry-pipe sprinkler systems.
 - Sprinkler guards must be provided where sprinklers are installed less than 8 feet above the floor.
 - Sprinkler heads and piping shall be mounted and routed above walking space – not above equipment racks or the equipment they will contain.

4.7.5 FLOOR-STANDING EQUIPMENT RACKS AND CABINETS

- A. Each telecommunications room shall be provisioned with a full set of floor-standing 7' high x 19" wide ANSI/TIA/EIA standard open-frame equipment racks to fill the room, regardless of whether or not equipment is required at the time of construction.
 - For minor remodel construction, this requirement may be waived given budget, project size, or other limiting factors.
 - The use of a wall-mounted swing rack or a wall-mounted hinged bracket may be acceptable, subject to WSUS approval via the SVR process.
- B. As required by Code, 36" clearances are required surrounding racks, cabinets and any equipment that may be mounted in the racks. See the sample telecommunications room plan drawings in Appendix 6.1 of the TDDG for further information.
- C. Racks shall be sized to accommodate, at a minimum, all existing and new equipment that is to be installed in the rack plus an additional 50% of space for additional equipment that may be added in the future. If a rack is more than 50% full at design time, a spare rack shall be specified.

4.7.5.1 FLOOR-STANDING EQUIPMENT RACKS

- A. See the sample floor plan details in Appendix 6.1 of the TDDG for rack arrangement guidance.
- B. Floor-standing racks shall be securely bolted to the floor, and shall be braced to the wall with cable ladder racking. Multiple racks in the same TR shall be interconnected with cable ladder racks.
- C. The following clearances are required around equipment racks:
 - 42" of clear space between the front of the rack and the facing wall, allowing for 36" of clear space after:
 - 6" for equipment mounted on the facing wall
 - 66" of clear space between the rear of the rack and the facing wall allowing for 36" of clear space after:
 - 24" of equipment is installed in the rack
 - 6" for equipment mounted on the facing wall
 - 36" of clear space is required on one side of an aisle of racks.

The Designer shall discuss with WSUS the potential for future requirements for additional racks, and identify spaces for future racks on the plan drawings. (See the sample telecommunications room plan drawings in Appendix 6.1 of the TDDG for further information).
- D. Racks shall be equipped with horizontal and vertical cable management modules both front and rear, with strain relief brackets to support proper cable bend radius and to maintain strain relief for the cabling. Vertical cable management modules shall include spools/posts to manage cable slack.
 - 1. Vertical cable management between racks shall be 12" wide.
 - 2. Vertical cable management on the sides of racks shall typically be 6" wide. Some applications, however, may require 8" or 10" wide vertical cable management.
- E. Sometimes an equipment cabinet is required for larger IT equipment (servers, large UPSs, etc.) with both front and rear mounting rails. The Designer shall discuss with WSUS the network electronics that will be hosted in each TR and shall design appropriate racks and cabinets to support the equipment. Racks and cabinets shall be shown on the rack elevation details in the plan drawings.
- F. Ladder racking shall be provided at 7 feet above finished floor, circling the room and crossing the room over the tops of the equipment racks.

4.7.5.2 TELECOMMUNICATIONS CABINETS

- A. When planning the size and location of TRs in existing buildings, the Designer shall make every reasonable effort to meet the requirements for telecommunications rooms. In certain instances, the only viable alternative may be the use of one or several telecommunications cabinets in lieu of TRs.
- B. In minor remodel projects, some buildings may not justify a separate room as the

telecommunications room. In some circumstances, sufficient space may not be available for a telecommunications room. In these instances, a wall-mounted or floor-standing telecommunications cabinet may be used.

- C. Wall-mounted cabinets shall be double-hinged to permit access to both the front and rear of the equipment. Care shall be taken to specify cabinets with strong hinges that do not begin to sag over time due to the weight of the cabinet's contents. Telecommunications cabinets shall be constructed of heavy gauge steel with lockable doors:
 - If the cabinet will be located in an occupied space, use a Plexiglas® door to reduce noise.
 - If the cabinet is not located in an occupied space, use a mesh-screened door to improve ventilation.
- D. Cabinets shall be sized to allocate space for cabling termination infrastructure, network electronics, and UPS equipment, and shall also include space allocated for future growth. Wall space shall be allocated to permit cabinets to fully swing open.
- E. Cabinets shall be equipped with horizontal wire management modules with strain relief brackets to support proper cable bend radius and to maintain strain relief for the cabling.
- F. Power and telecommunications cables for equipment housed within the cabinet are to be contained within the cabinet. Exposed wiring or cables are not permitted. Power and telecommunications cables routed to or from the cabinet shall be contained in conduit, surface-mounted raceway, or concealed within the adjacent wall.
 - Technical power outlets serving cabinets shall be mounted inside the cabinet.
- G. Each cabinet that hosts equipment that produces a significant heat load shall have front and rear screen doors, allowing air flow through the equipment. Cooling fans are typically not required.
- H. Each cabinet shall have a telecommunications grounding busbar (TGB) installed inside, in accordance with the grounding requirements discussed in the BICSI TDMM Chapter 9 *Bonding and Grounding (Earthing)*.
- I. The cabinet shall not be located in or adjacent to areas containing sources of electromagnetic interference (EMI). See TDDG *Section 4.2 Electromagnetic Compatibility* (above) for further information.

4.7.6 POWER REQUIREMENTS

- A. The Designer shall be responsible to determine that the power requirements for the telecommunications spaces are met as described in this document. For projects where an electrical engineer is involved, the Designer shall coordinate

directly with the engineer, and verify that the engineer's design documentation meets these requirements. For projects without the involvement of an electrical engineer, the Designer shall alert WSUS where additional power infrastructure is needed to meet the requirements.

- B. WSUS typically provides network electronics that provide Power-over-Ethernet. The Designer shall request power consumption data for the equipment that WSUS will use, and work with the electrical power distribution designer to ensure that the cooling capacity is sufficient to support the POE heat load.

4.7.6.1 BACKUP POWER (GENERATOR & UPS)

- A. All telecommunications rooms require backup power from both a standby generator and a UPS. WSUS uses VOIP telephone systems that require Power-over-Ethernet (POE) network switches to remain operational. The UPS equipment is intended to run long enough to allow the generator to strike up and deliver stable power.
- B. The Designer shall work with the Electrical Engineer to design an appropriately sized standby generator to provide power to:
 - All telecommunications rooms
 - All mechanical cooling serving telecommunications rooms
- C. Generally, WSUS provides rack-mounted uninterruptible power supply (UPS) equipment.
 - Centralized UPS equipment is primarily reserved for data center-class spaces. The Designer shall inquire with WSUS on a project-by-project basis whether a centralized UPS is desired for the project.
- D. The Designer shall work with the Electrical Engineer to design appropriate power receptacles that will be suitable to serve the Owner-provided UPS equipment that will be used on the project.
- E. The Designer shall reserve sufficient space at the base of an equipment rack in each telecommunications room to hold the Owner-provided UPS equipment.

4.7.6.2 TECHNICAL POWER PANELS

- A. The technical power circuits in each telecommunications room shall originate from a technical power panel, dedicated to serving the TR. In the absence of other influencing circumstances, the panel shall be sized for 100 Amp service. The technical power panel shall not be used to supply power to sources of electromagnetic interference such as large electric motors, arc welding, or industrial equipment.
 - The panel shall be located in the TR.
 - The technical power panel shall be labeled "Telecommunications Equipment Only."

- B. It is acceptable to use a single technical power panel to serve multiple telecommunications rooms.
- C. Some circumstances might not justify a dedicated technical power panel. In these cases, an available general-purpose electrical panel may be used. The Designer shall seek direction from WSUS regarding a decision to not design a dedicated technical power panel.

4.7.6.3 TECHNICAL POWER OUTLETS

- A. The Designer shall obtain electrical power connection/load requirements from WSUS for each piece of equipment, and tabulate the information for review and confirmation by WSUS. This equipment may include network electronics, UPS equipment, computers/servers, phone system equipment, voice mail systems, video equipment and service provider equipment.
- B. WSUS intends to provide UPS equipment for each telecommunications room that requires two 208V power sources:
 - One with unconditioned utility power
 - One with generator-backed power

The Owner-provided UPS equipment will provide 110VAC and 208VAC outlets to meet the needs of the Owner-provided network equipment, and will connect to power distribution units supporting rack-mounted equipment.

- C. At least two power outlets shall be provided (each with dedicated circuits) for exclusive use by telecommunications related electronic equipment.
 - Outlets shall be colored orange, labeled as “Technical Power” and shall show the panel and circuit numbers.
 - Where 110VAC Technical power outlets are required, outlets shall be equipped for “straight-blade plugs” (NEMA 5-20R), rather than twist-lock style receptacles.
 - Where 208VAC Technical power outlets are required, the Designer shall inquire with the WSUS ITPM to determine the plug requirements for the equipment to be served.
 - Each outlet shall be equipped with a dedicated insulated solid copper equipment-grounding conductor. Ground conductors serving technical power outlets **shall not** be *isolated* ground conductors.
 - See the telecommunications room plan details in Appendix 6.1 of the TDDG for technical power outlet locations.
- D. The Designer shall specifically investigate the potential need for voltage or Ampere requirements other than the typical 110VAC/20 Ampere power outlet. Some UPS and network switch equipment requires specialized plugs or electrical service. The Designer shall inquire with the WSUS ITPM to determine whether any dedicated or specialized circuit requirements exist.

4.7.6.3.1 FOR NEW CONSTRUCTION AND MODERNIZATION PROJECTS

- A. Faceplates for power receptacles and light switches in the TR shall be mounted at the surface of the plywood backboard (as opposed to being recessed into a cutout in the plywood backboard). The device boxes shall be recessed into the wall (not surface-mounted).

4.7.6.3.1.1 Telecommunications Rooms with One or Two Floor-standing Racks

- A. One duplex technical power outlet per floor-standing rack shall be provided to serve each rack. The outlet(s) shall be mounted on the side wall nearest the racks, approximately 18 inches behind the rack. Technical power outlets shall be mounted at the standard mounting height above the finished floor.
- B. The rack nearest the wall is expected to host a rack-mounted UPS at the base of the rack as well as a 72" vertical power strip attached to the vertical cable management on the non-wall side of the rack. The UPS will plug into the duplex power outlet, and the power strip will plug into the UPS.
- C. Electronic equipment in the second rack is typically powered by the vertical power strip. However, if necessary, another UPS can be installed in the base of the second rack, and the power cord can be routed beneath the first UPS to the second rack-dedicated technical power outlet.
- D. Typically, the contractor is required to furnish and install the vertical power strip, and WSUS furnishes and installs the UPS equipment.
- E. For racks where WSUS intends to install equipment with dual-redundant power supplies, two duplex technical power outlets with separate circuits shall be provided for those racks. The Designer shall inquire with WSUS whether equipment with dual power supplies will be used.

4.7.6.3.1.2 Telecommunications Rooms with More than Two Floor-standing Racks

- A. The first two racks are served as described above.
- B. A dedicated duplex technical power outlet (pedestal style) shall be floor-mounted near the vertical cable management of each additional rack.
- C. Conduit for each pedestal outlet shall be concealed in the floor where possible. Otherwise, the conduit shall be routed exposed from the wall to the pedestal, above the base-plates of the first and second racks. The bottom rack spaces (reserved for UPS equipment) shall not be obstructed by the power conduit.

4.7.6.3.1.3 Other Technical Power Outlets

In addition to the outlets intended to serve the racks, a minimum of one duplex technical power outlet shall be provided per wall (centered on the wall) except for the wall adjacent to the racks. For walls more than 10' in length, a minimum of 2 outlets shall be provided, and at intervals of no more than 6 feet between outlets.

4.7.6.3.2 FOR MINOR REMODEL PROJECTS

- A. The design shall include technical power outlets according to the "new

construction” requirements, wherever possible. However, for some projects it may not be realistic or practical to meet those requirements. The following two paragraphs describe an alternative arrangement of technical power outlets that may be approved on a project-by-project basis via the SVR process:

- If it is not practical to install a new power outlet at the base of each equipment rack, it may be acceptable to serve the rack’s power needs from a wall-mounted outlet.
 - If power outlets are not installed at the base of each rack, the number of wall-mounted technical power outlets shall be increased to an interval of one outlet every 6 feet. Power outlets in this arrangement shall be located such that they are conveniently aligned with the equipment racks to avoid inadvertent disconnection of the power cords.
- B. Where telecommunications backboards are applied to existing walls with existing power outlets and light switches, the design shall require backboards to be provided with cutouts permitting access to the existing electrical devices.

4.7.6.4 ADDITIONAL CONVENIENCE POWER OUTLETS

- A. In addition to the technical power outlets described above, the design shall require the Contractor to provide other duplex convenience outlets (120VAC, 15 Ampere) that would be available for use with power tools and testing equipment. Each outlet shall be labeled with its panel identification and circuit number.
- B. Where telecommunications cabinets are used in lieu of a TR, there shall be at least one general-purpose convenience power outlet (120VAC, 15 Ampere) located within six feet of each telecommunications cabinet. This outlet shall be colored consistently with other convenience outlets in the building. The general-purpose outlet shall not be used to power telecommunications equipment associated with the cabinet.
- For minor remodel projects, the number of convenience outlets in a TR can be reduced.
- C. Convenience power outlets can be circuited to the technical power panel.

4.7.7 GROUNDING, BONDING, AND ELECTRICAL PROTECTION

All equipment racks, metallic conduits and exposed non-current-carrying metal parts of telecommunications and information technology equipment in the TR shall be bonded to the TMGB. Refer to Chapter 9 *Bonding and Grounding* in the BICSI TDMM and TDDG Section 4.9 for more information regarding the design of grounding, bonding and electrical protection systems.

- A. Grounding and bonding conductors shall be sized according to the requirements in ANSI/TIA/EIA J-STD-607A.

4.7.8 CABLES ENTERING TELECOMMUNICATIONS ROOMS

All cables shall be fully supported and properly transitioned throughout the length of the cables, including proper bend radius fittings at pathway transitions. Where cabling is routed vertically, it shall be appropriately secured such that the weight of the cabling does not subject the cabling to stresses that could potentially reduce the performance of the cabling.

4.7.9 ENTRANCE FACILITIES

4.7.9.1 OUTSIDE PLANT CONDUIT ENTRANCE

All WSUS utility services are delivered to the main demarc on campus. Therefore, the concept of an Entrance Facility at WSUS buildings is limited to entrance conduits from the outside plant into the main telecommunications room in the building. Typically, WSUS prefers to co-locate the entrance facility with the main telecommunications room.

4.7.9.2 ROOFTOP CONDUIT ENTRANCE

The top most telecommunications room in each building shall have a minimum of two 2" conduits routed to the roof. The conduits shall be terminated above the roof with a weatherhead.

Roof top conduits can be used to serve antennae for service inputs (satellite, emergency responder radio, cellular service) or provide pathway for cabling serving cameras or other devices mounted on the roof.

4.7.9.3 NON-WSUS TENANT DEMARC

For buildings where non-WSUS tenants will reside, those tenants will probably need utility services delivered directly to the building. Therefore, wall space shall be allocated in the main telecommunications room of the building for limited utility demarc applications, in a location near the entrance conduits.

4.8 Firestopping

Please refer to Chapter 8, *Firestopping* in the BICSI TDMM for general information regarding the design of firestopping for telecommunications infrastructure. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

- A. The Designer shall pay careful attention to the fire ratings of existing and new walls. Wherever penetrations are made through fire-rated walls, the Drawings shall identify the firestopping requirements.
- B. Penetrations through fire-rated walls and floors shall be firestopped in accordance with the requirements of the manufacturer of the firestopping materials, and to satisfy local code officials.

- C. The Designer shall avoid design solutions calling for penetration of fire walls, fire barriers, fire partitions, smoke barriers, and smoke partitions when other reasonable cable routing options exist.
- D. The predominant color of fire-rated pathway devices shall be red.
- E. WSUS prefers to use STI EzPath for penetrations through fire-rated walls and floors. This preference is based on the experience that it is difficult to keep putty-based materials intact inside conduit sleeves, especially vertically oriented sleeves, particularly through multiple moves-adds-changes.

4.9 Bonding and Grounding (Earthing)

Please refer to Chapter 9, *Bonding and Grounding (Earthing)* in the BICSI TDMM for general information regarding the design of grounding, bonding and electrical protection systems. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

- Grounding and bonding conductors shall be sized according to the requirements in ANSI/TIA/EIA J-STD-607A.

4.10 Power Distribution

Please refer to Chapter 10, *Power Distribution* in the BICSI TDMM for general information regarding the design of power distribution for telecommunications infrastructure. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

- A. The Designer shall be responsible to determine that the electrical power distribution requirements supporting the telecommunications infrastructure are met as described in this document.
- B. For projects where an electrical engineer is involved, the Designer shall coordinate directly with the engineer, and verify that the engineer's design documentation meets these requirements. For projects without the involvement of an electrical engineer, the Designer shall alert WSUS where additional power infrastructure is needed to meet the requirements.
 - 1. Please refer to Chapter 4, *Work Areas* in the BICSI TDMM and also in TDDG Section 4.4 Work Areas for information on the power outlet requirements for work areas.
 - 2. Please refer to Chapter 7, *Telecommunications Spaces* in the BICSI TDMM and also in TDDG Section 4.7 Telecommunications Spaces for information on the power outlet requirements for TRs.

- WSUS typically provides network electronics that provide Power-over-Ethernet.
 - The Designer shall request power consumption data for the equipment that WSUS will use, and will size the power distribution infrastructure sufficient to support this equipment.
3. Please refer to Chapter 21, *Data Centers* in the BICSI TDMM and also in TDDG Section 4.21 Data Centers for information on the power outlet requirements for data centers.
- WSUS data centers will typically be either Tier II or Tier III systems.
 - The Designer shall inquire which tier is to be designed for each project, and design appropriate power distribution systems to support the Tier designation.
- C. The Designer shall inquire which type of power conditioning / power protection equipment should be designed for each project.
- WSUS recognizes that flywheel-based UPS equipment is available. However, the initial cost of flywheel equipment is typically very high. As a result, the return on investment is low with a lengthy time to payback. For most applications, flywheel-based UPS systems are probably cost-prohibitive.

4.11 Telecommunications Administration

Please refer to Chapter 11, *Telecommunications Administration* in the BICSI TDMM for general information regarding the documentation and labeling of telecommunications infrastructure. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

4.11.1 IDENTIFICATION STRATEGY

- A. The “identifier” is the unique name or description assigned to a given telecommunications infrastructure component. The Designer shall assign identifiers to the telecommunications infrastructure components listed below and clearly show the identifier assignments on the Construction Documents.
- B. While it is the Contractor’s responsibility to provide marked-up drawings to the Designer indicating any construction-related changes to the identifiers, the Designer shall verify that the identifiers are clearly and accurately shown on the record drawings.
- C. Telecommunications components shall **not** be labeled with an application-specific identifier. Ports shall **not** be labeled with the name or function of the device that is served by the port (server name, computer type). Also, the use of “V-#” and “D-#” are inconsistent with the industry standard-based philosophy of

designing cabling systems that are independent of the application, and are therefore not permitted.

- D. The Designer shall prepare construction specifications that shall contain a comprehensive listing of the identification strategy requirements.

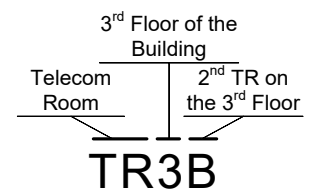
4.11.1.1 NEW TELECOMMUNICATIONS DISTRIBUTION SYSTEMS

The items listed below shall be shown on the Construction Documents. The Designer shall assign the identifiers to the telecommunications components based on the following *suggested* identification strategy. The circumstances of each project may require adjustments. The Designer shall discuss with WSUS any recommendations for customization and cooperatively develop an identification strategy, prior to adopting any customizations.

- A. WSUS has a campus building numbering scheme that shall be incorporated into all applicable labeling. Each building on campus has been assigned a 4- or 5-digit numeric code. The Designer shall obtain the official numbering scheme from the ITPM, including the new number for a new building (if applicable).

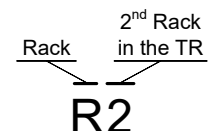
Number	Abbreviation	Name
9012	EWUC	Phase 1 Classroom Building
9013	SHSB	Health Science Building
9015	HERB	Innovate Washington (formerly Sirti)
9016	SNURS	Nursing
9018	PBS	Biomedical and Health Sciences
9021	CCRS	South Campus Facility
9023	ROP	Administrative Annex
9024	VetMed	Veterinary Medicine
9032	Ignite	Spokane Technology Center

- B. Telecommunications Rooms, Equipment Rooms and Data Centers shall be identified by room number. However, if a telecommunications room does not have an assigned room number, then the room shall be identified as "TR#@", where "#" is the floor number on which the telecommunications room resides, and "@" represents a sequentially assigned letter to distinguish between multiple rooms on the floor.



- For example: a telecommunications room located in Room #1242 in a building would be identified as "1242".
- For example: a building with two un-numbered telecommunications rooms on the third floor would have rooms labeled "TR3A" and "TR3B".

- C. Racks in telecommunications rooms shall have identifiers of the form "R#" where "R" stands for "Rack" and "#" is the sequential rack number within a given TR, numbered left to right while facing the front of the racks.



- For example: The first rack in a given telecommunications room would have the label "R1", the second "R2" and so on.

- D. Backbone Cables shall have identifiers of the form of “aaaaa-bbbbbb-cccc-ddddd-eeee”, where:

- aaaaa Source Building Number (source points to nearest MCF)
- bbbbbb Telecommunications Room Number at Source
- ccccc Destination Building Number (towards the customer/outlet)
- ddddd Telecommunications Room Number at Destination
- eeee Cable Number, as follows:
 - 001-999 for UTP cables
 - FM01-FM99 for Multimode Fiber cables, with strand count
 - FS01-FS99 for Singlemode Fiber cables, with strand count
 - X01-X99 for Coax cables
 - Z01-Z99 for Composite cables

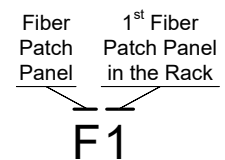
Cables shall be labeled within 6 feet of entrance into a telecom room and within 12” of the fiber optic patch panel. Cables shall also be labeled twice in maintenance holes, within 3 feet of the entrance and exit conduits. The labels shall designate the origin, destination and owner of the cable.

- For example: A 24-strand singlemode fiber optic cable running between Telecommunications Room 21 in the Phase 1 building (9017) and Telecommunications Room 020T in the Nursing Building (9012) shall be numbered: 9017-021T-9012-020T-FS24.

Source Building	Source Telecom Room	Destination Building	Destination Telecom Room	Cable Type
9017	21	9012	020T	FS24

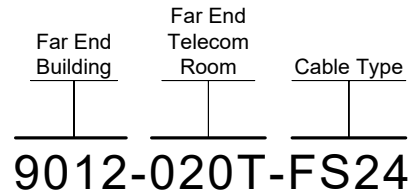
- E. Fiber Optic Patch Panels shall have identifiers sequentially numbered in the form of “F#” where “F” stands for “Fiber” and “#” is the sequential fiber optic patch panel number terminated within a given telecommunications room. The numbering sequence does not restart for each rack.

- For example: The first fiber optic patch panel would be labeled “F1”. The second fiber optic patch panel would be labeled “F2”.



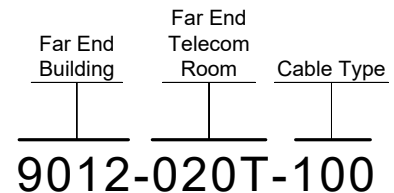
- F. Ports on Patch Panels for Fiber Optic Cabling are typically pre-labeled by the manufacturer with sequential numbers (i.e. 1 to 12).
- In addition to the pre-labeling, each bulkhead/connector panel shall also be labeled with the far end termination point and type of the cable terminated at that port, in the form of “cccc-ddddd-eeee” (referencing the cable numbering discussed above).

- For example: the bulkhead/connector panel in a patch panel terminating a 24-strand singlemode fiber optic cable whose far end terminates in Telecommunications Room 020T in the Nursing Building (9012) shall be numbered: 9012-020T-FS24.



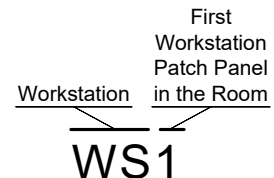
- G. BEPs, 110-Blocks and Voice Patch Panels for Copper Backbone Cabling shall be labeled with the far end termination point and cable of the cable terminated at that port, in the form of “cccc-ddddd-eeee” (referencing the cable numbering discussed above).

- For example: the BEPs, 110-Blocks and Voice Patch Panels for a 100-pair copper cable whose far end terminates in Telecommunications Room 020T in the Nursing Building (9012) shall be numbered: 9012-020T-100.



- H. Workstation Horizontal Copper Patch Panels shall have identifiers sequentially numbered in the form of “WS#” where “WS” stands for “Workstation” and “#” is the sequential copper patch panel number terminated within a given telecommunications room. The numbering sequence does not restart for each rack.

- For example: the first copper patch panel would be labeled “WS1”. The second copper patch panel would be labeled “WS2”.

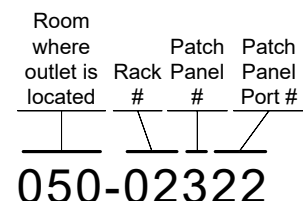


- I. Patch Panel Ports for Horizontal Cables shall have identifiers in the form of “aaaaa-bbccdd”, where:

- aaaaa **Room Number** where outlet is located
- bb **Equipment Rack Number**
- c **Patch Panel Number**
- dd **Patch Panel Port Number:**
 - 01-48 for UTP port
 - FM01-FM99 for Multimode Fiber port
 - FS01-FS99 for Singlemode Fiber port
 - X01-X99 for Coax port

Labels shall be applied to the front of the patch panel adjacent to each port, and also on the cable behind the port within 4” of the termination.

- For example: a horizontal UTP cable terminated in patch panel port 22 of workstation patch panel 3 in rack 2 in telecommunications room 020T, serving an outlet in office 050 would be labeled in the telecommunications room as follows: “050-02322”.



- C. The Designer shall review the cable test results submitted by the Contractor. The test results shall be the actual native machine test results downloaded from the test equipment. In particular, the Designer shall check for the following items on the cable test reports:
- The cable test report shall be automatically produced by the test equipment.
 - The report shall indicate that the cable passed the test. It shall also indicate the date of calibration, the software version and the name of the technician or conducted the test. The reports shall also include graphical results of the performance curves obtained during the testing.
 - Indications that the cabling meets distance limitation requirements.
 - Indications that the wire-map of the cable is correct.
 - Indications that the cable test equipment was properly configured. For copper cabling, the test equipment's configuration parameter for Nominal Velocity of Propagation (NVP) shall match the value stated by the cabling manufacturer for the type of cable installed.
 - Marginal test results (typically indicated with an asterisk "**") are only acceptable when the condition is "over length" and when the over-length situation was intentional during design. For example, a low bandwidth device might be served by a cable that would otherwise be too long to support a high bandwidth device. Over-length issues due to choice of routing or extra service loops are not acceptable.
 - For Fiber Optic Cabling: the cable test report shall indicate a headroom dB value that is equal to or better than the value calculated in the link-loss budget.
- D. The cabling performance characteristics shall meet or exceed the performance guaranteed by the manufacturer, which may exceed standard industry requirements. In other words, even though a particular cable might pass its tests, the cable might still be rejected (requiring re-termination or replacement) if it does not meet the higher standard of performance that the manufacturer may list for its products.
- E. WSUS may choose to spot-test cabling to back-check the Contractor's test results.
- F. WSUS may choose to hire a third-party cable test company to conduct an independent cabling test.
- G. The final test results shall have been verified by the Designer to be acceptable before submission to WSUS. Test results shall be submitted to WSUS in electronic form, both in PDF form and also the original test result data files.
- H. Contractors shall be required to retain a copy of the test reports for a period of at least 5 years after installation.

4.13 Design, Construction and Project Management

Please refer to Chapter 13, *Design, Construction and Project Management* in the BICSI TDMM for general information regarding design, construction and project management of telecommunications infrastructure.

Please refer to TDDG Section 3 *Project Procedures* for WSUS-specific telecommunications project procedure requirements.

4.14 Private CATV Distribution Systems

Please refer to Chapter 14, *Private CATV Distribution Systems* in the BICSI TDMM for information regarding the design of telecommunications infrastructure to support private CATV distribution systems at WSUS facilities.

The Designer shall inquire with WSUS to determine where cable television outlets are required for a given project. CAT6 cabling is required for each television application at WSUS.

4.15 Distributed Paging Systems

Please refer to Chapter 15, *Overhead Paging Systems* in the BICSI TDMM for information regarding the design of telecommunications infrastructure to support overhead paging systems at WSUS facilities.

These systems are typically not used at WSUS. However, the Designer shall inquire with WSUS to determine whether emergency response paging systems are required for a given project.

4.16 Building Automation Systems

Please refer to Chapter 16, *Building Automation Systems* in the BICSI TDMM for information regarding the design of telecommunications infrastructure to support building automation systems at WSUS facilities.

- A. ANSI/TIA/EIA-862 applies to telecommunications infrastructure serving building automation systems (BAS). The Designer shall pay particular attention to the following BAS issues:
 - Verify that the voltage and current requirements of each BAS application are satisfied by the cabling materials to be installed.
 - Verify that a suitable horizontal connection point (HCP) is installed for each BAS application.
- B. BAS devices are increasingly converging onto structured cabling systems. While the design of these systems is typically outside the scope of work of the telecommunications infrastructure designer, the Designer shall design the telecommunications cabling required to support these systems.

- C. Typically, BAS systems require telecommunications cabling routed from the devices to a patch panel termination point in a designated mechanical room or other location managed by building maintenance personnel. In addition to the device-specific cables, other cables shall be designed from the telecommunications rooms to the BAS patch panels, to permit these systems to gain access to the data networks.
- D. Horizontal connection points are only required for BAS applications. Do not use an HCP for typical voice/data/video applications.

4.17 Data Network Design

Please refer to Chapter 17, *Data Network Design* in the BICSI TDMM for general information regarding the design of telecommunications infrastructure for serving local area networks. The following requirements take precedence over the BICSI TDMM guidelines for telecommunications infrastructure at WSUS facilities:

- A. All WSUS facilities use the Ethernet LAN protocol. Telecommunications infrastructure for all WSUS facilities shall be designed, installed, and tested to support the Institute of Electrical and Electronic Engineers (IEEE) Ethernet 802.3 standards. WSUS networks use the 1000Base-X Gigabit Ethernet protocol based on the IEEE 802.3z standard. All newly installed cabling shall support this protocol. The Designer shall give careful consideration to the multimode fiber optic distance limitations and signal loss limitations (less than 2.5 dB end-to-end) necessary to support the IEEE 802.3z protocol. WSUS networks are typically based on Cisco switches (power-over Ethernet), with 1GB backbones and 1GB service to the work area.
- B. The design of the network electronics is done by WSUS and is outside the scope of work of the telecommunications designer.
- C. The Designer shall coordinate with the WSUS ITPM to determine the requirements for supporting the network electronics in each space. The design shall provide rack space to host WSUS' network equipment.

4.18 Wireless

Please refer to Chapter 18, *Wireless* in the BICSI TDMM and the BICSI Wireless Design Reference Manual (WDRM) for information regarding the design of telecommunications infrastructure to support wireless and microwave telecommunications systems at WSUS facilities.

- A. WSUS currently uses Aruba wireless access point equipment in its buildings. This equipment operates with Power-over-Ethernet and requires one cable per device. The Designer shall accommodate POE equipment in the design, including the power and cooling requirements.
- B. The Designer shall work cooperatively with the WSUS ITPM to design

telecommunications infrastructure to appropriately support wireless technologies. The Designer shall show the locations where wireless access points (WAP) are desired on the drawings. On occasion, WSUS may request services to identify appropriate WAP locations and prepare associated coverage and signal strength maps. All jacks should be mounted above the ceiling grid.

4.19 Electronic Safety and Security

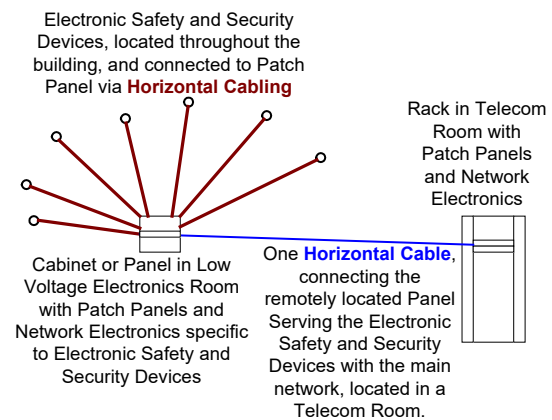
Please refer to Chapter 19, *Electronic Safety and Security* in the BICSI TDMM for general information regarding the design of telecommunications infrastructure for serving electronic safety and security systems.

Electronic safety and security (ESS) devices are increasingly converging onto structured cabling systems. While the design of these systems is typically outside the scope of work of the telecommunications infrastructure designer, the Designer shall design the telecommunications cabling required to support these systems.

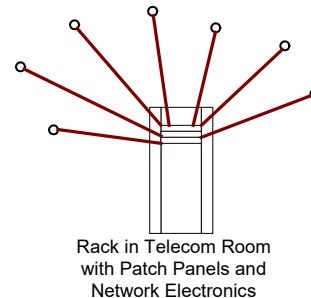
Sometimes ESS systems require telecommunications cabling routed from the devices to a patch panel termination point in a designated low-voltage electronics room or other location managed by building security personnel. In addition to the device-specific cables, additional cables shall be designed from the telecommunications rooms to the ESS patch panels, to permit these systems to gain access to the data networks.

Other times, ESS systems can be cabled directly to patch panels in the telecommunications rooms just like any other computer or telephone device.

The diagrams above depict the differences between these two solutions. The Designer shall inquire on a project-by-project basis which solution to apply to a given project. Non-technical issues will frequently affect which solution is used.



Electronic Safety and Security Devices, located throughout the building, and connected to Patch Panels in Telecom Room via **Horizontal Cabling**



4.20 Outside Plant

Please refer to Chapter 20, *Outside Plant* in the BICSI TDMM and the BICSI OSPDRM for information regarding the design of outside plant telecommunications infrastructure.

See Section 4.6.3 above.

4.21 Data Centers

Please refer to Chapter 21, *Data Centers* in the BICSI TDMM for general information regarding the design of telecommunications infrastructure for serving data centers. Generally speaking, WSUS follows the TIA-942 Data Center Standard in the design of data centers and larger equipment rooms. The requirements below take precedence over the BICSI TDMM guidelines.

The requirements for small-scale equipment rooms are the same as for telecommunications rooms.

The Designer shall inquire with WSUS whether an equipment room in a given project is intended to be designed with telecommunications room features or data center features.

4.21.1 SIZING CONSIDERATIONS

- A. The Designer shall consult with the WSUS ITPM to determine any sizing requirements for the Data Center on a project-by-project basis. The design shall include a minimum of 25% vacant space for future growth.
- B. The power consumption profile of equipment to be hosted in the data center and its associated heat-load profile are the two key parameters for sizing a data center. The Designer shall work with WSUS ITPM to identify the power consumption per cabinet footprint, which will have a direct correlation to the cooling requirements of the space. The quantity of equipment cabinets that can be powered and cooled in the space drives the sizing plan.
 - During the life of the data center, advances in technology may shrink the space requirements for each server, making more physical space available for additional servers. However, if there is not sufficient power to support another server, or sufficient cooling capacity to remove the heat produced by another server, then the additional space is unusable.
- C. The WSUS ITPM shall approve the final space requirements and design layout for the equipment and racks.

4.21.2 TIER CLASSIFICATION

WSUS data centers are typically designed for Tier II+ classification (redundant components, single distribution path, and N+1 redundancy). However, the Designer shall inquire with the ITPM on a project-by-project basis for the desired Tier classification of each data center or equipment room.

4.21.3 ARCHITECTURAL CONSIDERATIONS

The Data Center shall be separated from other occupancies within the building by fire-resistant-rated construction of not less than 1 hour.

4.21.4 ENVIRONMENTAL PROVISIONING

Environmentally friendly solutions shall be considered in the design of data center cooling systems, incorporating heat reclamation and non-mechanical cooling features where reasonable and practical.

Environmental management and monitoring systems shall be designed for data centers.

Consideration shall be given to both cooled cabinets and whole-room cooled air solutions.

Air conditioning systems for technology/server and UPS rooms shall be supported by emergency power systems. Typically, a generator will perform this function.

4.21.5 FIRE DETECTION AND SUPPRESSION

All Data Centers shall be protected by a non-water-based suppression system.

4.21.6 FLOOR-STANDING EQUIPMENT RACKS

Some IT equipment requires an equipment rack with both front and rear mounting rails. The Designer shall discuss with WSUS the network electronics that will be hosted in each rack in each Data Center and shall show this equipment on the rack elevation details in the plan drawings. The Designer shall also discuss with WSUS the potential for future additional racks, and identify spaces for the future racks on the plan drawings.

4.21.7 TELECOMMUNICATIONS CABINETS

- A. Other styles of equipment racks and cabinets might be used in the Data Center, some of which may be proprietary to a particular system or service provider. The Designer shall plan the Data Center layout to make allowances for proprietary cabinets and racks, and allow expansion room for future equipment.
- B. Floor-standing cabinets shall have front and rear hinged doors to permit access to both the front and rear of the equipment. Telecommunications cabinets shall be constructed of heavy-gauge steel. The side panels of the cabinet shall be removable for maintenance accessibility.
- C. Each cabinet shall be vented and, where appropriate, equipped with cooling fans.

4.21.8 POWER REQUIREMENTS

4.21.8.1 TECHNICAL POWER PANELS

- A. A standby generator is required for each Data Center.
- B. A separate supply circuit serving the room shall be provided and terminated in its own electrical panel located in the Data Center. This power panel shall be designated as "Data Center Technical Power." The Data Center technical power panel shall be used exclusively for supplying power to electronics equipment in the equipment room. Sizing of electrical power supply is dependent upon the equipment types and equipment load, and shall be calculated on a case-by-case basis, including sufficient spare capacity for future growth.
- C. The technical power circuits in each Data Center shall originate from a technical power panel, dedicated to serving the Data Center. The technical power panel shall not be used to supply power to sources of electromagnetic interference such as large electric motors, arc welding, or industrial equipment.
- D. Power for critical network components such as servers, routers, switches, and telephone systems shall always be provided through at least one uninterruptible power supply (UPS).
- E. WSUS will consider the use of centralized UPS equipment as applications warrant, such as for Data Centers. However, if WSUS wishes to use a centralized UPS, the following requirements shall be met:
 - Some centralized UPS equipment may vent noxious battery gases. The UPS may therefore need to be housed in a room that is equipped to properly vent the gases. Centralized UPSs shall not be located within the Data Center itself. Rooms housing centralized UPS systems shall have the same environmental provisioning features as the Data Center.
 - Some battery manufacturers claim that valve-regulated lead-acid batteries do not emit gases and therefore might not require mechanical systems for venting battery gases. The Designer shall evaluate such claims for applicability on each project.
 - The UPS' battery bank shall be sized to provide a minimum of two hours of run time for the supported low-voltage systems hardware. The Designer shall request direction from the WSUS ITPM regarding project specific needs for increased run time.
 - Upon installation, a qualified electrician shall test new centralized UPS units for correct output voltage prior to connecting electronic equipment.
 - Centralized UPS equipment shall be provided with a network interface card so that the UPS can communicate via the network with servers and other equipment to orchestrate a coordinated safe-shutdown of the equipment in the event of an extended power outage. The telecommunications cabling design shall require a telecommunications outlet located in the centralized UPS room near each UPS to support the UPS' network connection.

- WSUS recognizes that flywheel-based UPS equipment is available. However, the initial cost of flywheel equipment is typically very costly, and as a result, the return on investment is low with a lengthy time to payback. For most applications, flywheel-based UPS systems are probably cost-prohibitive.
- F. WSUS typically uses network electronics that provide Power-over-Ethernet (POE).
- G. The Designer shall request power consumption data for the equipment that WSUS will use, and will size the power distribution infrastructure sufficient to support this equipment.

4.21.8.2 TECHNICAL POWER OUTLETS

- A. Generally, the power outlet requirements that are applicable to telecommunications rooms are also applicable to equipment rooms. See TDDG *Section 4.7.6 Power Requirements* (above).
- B. The Designer shall obtain connection/load requirements from WSUS for each piece of equipment, and tabulate the information for review and confirmation by WSUS. This equipment may include network electronics, UPS equipment, computers/servers, phone system equipment, voice mail systems, video equipment and service provider equipment.
- C. Some telephone PBX equipment, UPS equipment and network switch equipment requires specialized plugs or electrical service. The Designer shall specifically investigate the potential need for voltage or current requirements other than the typical 120VAC/20 Ampere power outlet, and shall coordinate with the design team to design the electrical power infrastructure to serve the needs of the equipment.

4.21.8.2.1 FOR REMODEL PROJECTS

If an equipment room is truly required in a remodel project, budget limitations and other constraints shall be resolved through actions that do not deviate from meeting the requirements of this document. In particular, the electrical power requirements of equipment in an equipment room shall not be discounted or taken lightly.

4.21.8.3 CONVENIENCE POWER OUTLETS

Convenience power outlets shall be provided as described (above) in TDDG *Section 4.7.6 Power Requirements* (above).

4.21.9 GROUNDING, BONDING, AND ELECTRICAL PROTECTION

All equipment racks, metallic conduits and exposed non-current carrying metal parts of telecommunications and information technology equipment in the Data Center shall be bonded

to the TGB. Please refer to Chapter 9, *Bonding and Grounding (Earthing)* in the BICSI TDMM and TDDG Section 4.9 for more information regarding the design of grounding, bonding and electrical protection systems.

- The Data Center requires a dedicated/isolated ground wire routed inside a metallic conduit directly from the main electrical service-grounding electrode for PBX equipment. This ground wire is in addition to and separate from the telecommunications grounding system.
- Grounding and bonding conductors shall be sized according to the requirements in ANSI/TIA/EIA J-STD-607A.

4.22 Health Care

Please refer to Chapter 22, *Health Care* in the BICSI TDMM for general information regarding the design of telecommunications infrastructure for serving health care facilities.

WSUS owns very few health care-related facilities. The likelihood of encountering a project of this type is low.

4.23 Special Design Considerations

Please refer to Chapter 23, *Special Design Considerations* in the BICSI TDMM for information regarding the design of telecommunications infrastructure in accordance with the Architectural Barriers Act Accessibility Standard (ABAAS) requirements for WSUS facilities.

The Designer shall inquire about the requirements for any special design considerations, including:

- Coin-operated and other public-use telephones within WSUS facilities
- Spaces within WSUS facilities which must include ABAAS features
- Point-of-Sale applications
- ATM Machines
- Reception Areas
- Digital Signage

4.24 Residential Cabling

Please refer to Chapter 24, *Residential Cabling* in the BICSI TDMM for information regarding the design of telecommunications infrastructure to support residential facilities within WSUS facilities.

The WSUS campus currently does not include any residential-type facilities. The likelihood of encountering a project of this type is low.

Generally speaking, WSUS-owned residential facilities shall be provided with the same telecommunications infrastructure materials and methods as are used for all other WSUS facilities, except where specifically noted in this document.

The Designer shall inquire about whether a “residential cabling” solution is required for a particular project.

4.25 Codes, Standards and Regulations

Please refer to *Appendix A: Codes, Standards and Regulations* in the BICSI TDMM for general information regarding the codes, standards and regulations that apply to telecommunications infrastructure.

5 Construction Document Content

This section of the TDDG describes the content requirements that the Designer shall include when creating the Construction Documents⁵. This content is in addition to the content found in some generally accepted document sets.

The documents produced by the Designer and the services provided by the Designer shall comply with the requirements in the Conditions of the Agreement and the Instructions for Architects and Engineers doing Business with Division of Engineering and Architectural Services. In addition to these requirements, the Designer shall also meet the requirements in this document, including the Construction Document content requirements in this section.

Construction Documents shall communicate a fully detailed and coordinated design (rather than making adjustments in the field during construction) and are expected to result in reduced construction costs and fewer change orders. The level of detail required to meet this objective may be substantially greater than some telecommunications designers may be accustomed to providing.

The Designer shall include the following content in the Construction Documents:

5.1 Plans and Drawings

5.1.1 GENERAL

The telecommunications portion of the Construction Drawing set shall include the following:

- Cover Sheet
- Sheet List
- Site Map
- Symbol Schedule
- List of Abbreviations
- Plan Sheets
- Elevation Diagrams
- Schematic Diagrams
- Construction Details
- Demolition

All plan sheets shall be scaled, shall indicate the scale and shall show a north arrow. All plan sheets shall show a key plan when the building or site is too big to fit on a single sheet.

⁵ As of this writing, the Conditions of the Agreement and the Instructions for Architects and Engineers Doing Business with Division of Engineering and Architectural Services (both published by the Washington State Department of General Administration) make reference to the term “Construction Drawings.” However, the Manual of Practice from the Construction Specifications Institute (CSI) defines “Construction Documents” as a subset of the “Contract Documents” and indicates that drawings, specifications and other written documentation are contained within the Construction Document subset. The TDDG will use the term “Construction Documents” according to CSI’s definition.

Equipment and cable identifiers shall be shown on the drawings and diagrams.

5.1.2 OUTSIDE PLANT SITE PLAN DRAWINGS

- A. Provide drawings showing a scaled telecommunications distribution site plan. These drawings shall show the following:
- Maintenance hole or handhole locations (labeled with their identifiers)
 - Complete ductbank routing, details and elevations
 - Conduit sizes, quantities and arrangements
 - Section cuts
 - Existing and new surface conditions
 - Outside plant copper telecommunications cabling, including pair counts
 - Outside plant fiber optic telecommunications cabling, including fiber types and strand counts
 - Locations of buildings, roads, poles, existing underground utilities and other obstructions
- B. These sheets should also identify coordination arrangements where conflicts with site work for other disciplines could possibly arise, in particular indicating the separation distances between telecommunications and power or steam. The sequencing of site work also should be shown, if applicable.
- C. The site plan shall show the cabling from the service providers (cable television, telephone, etc.) and shall indicate the requirements for owner-provided maintenance holes or handholes and pathway to the point of demarcation.
- D. These sheets should also identify coordination arrangements where conflicts with site work for other disciplines could possibly arise, in particular indicating the separation distances between low-voltage and power or steam. The sequencing of site work also should be shown, if applicable.

5.1.3 MAINTENANCE HOLE/HANDHOLE BUTTERFLY DIAGRAMS

- A. Butterfly diagrams are a combination of tabular information and a schematic diagram used to organize and communicate information related to the conduits and cabling in each maintenance hole and handhole. These diagrams are CAD files to be included in the project's drawing set.
- B. The Designer shall provide a set of butterfly diagrams depicting each maintenance hole or handhole affected by the project, and showing new cabling as well as existing cabling to remain in the maintenance hole or handhole.
- Ducts to be used for new cabling shall be assigned during the course of design, not during construction. Duct assignments must be approved by WSUS prior to the release of construction documents.

- C. A second set of butterfly diagrams shall be provided for each maintenance hole or handhole that contains existing cabling intended to be demolished under the project.
- D. The diagrams shall be formatted as shown in the sample butterfly diagram in Appendix 6.6. Upon request, WSUS will provide an electronic AutoCAD file of this diagram to be used as a template as well as electronic CAD files for each butterfly diagram affected by a project.

5.1.4 INSIDE PLANT PLAN DRAWINGS

- A. Scaled plan drawings shall be provided for each building showing the telecommunications applications and cabling inside the building. These drawings shall show the following:
 - Routing of new pathway to be constructed during the project.
 - The content of the drawings shall be coordinated with other disciplines and shall be representative of the complete pathway route that the Contractor shall use, rather than a schematic depiction.
 - It is expected that the Designer will expend considerable coordination effort during the design process. Non-coordinated pathway/raceway is not acceptable to WSUS.
 - Approximate locations of junction boxes and conduit bends.
 - The cable quantities and the raceway at any given point in the system.
 - Backbone distribution cabling.
- B. Where new cabling will be pulled into existing conduits, the Construction Documents shall show the routes of each *existing* conduit. Where it is not possible to determine the routing of existing conduits, the Designer shall inform the WSUS ITPM and seek direction on whether to use the existing conduits or design new conduits for use on the project. Typically, the Designer is required to identify such conditions during field investigation activities.

5.1.5 DEMOLITION

- A. Any existing equipment and cabling intended to be no longer in use following the new installation shall be removed (salvaged and returned to the Owner undamaged and in working condition) as a part of the project. WSUS uses salvaged equipment as spare parts to support the existing equipment in other buildings.
- B. Existing cabling to be demolished shall be shown on the plans and schematic diagrams. Separate demolition plan sheets and schematic diagrams shall be provided for projects with extensive cable demolition.

5.1.6 TELECOMMUNICATIONS ROOM PLAN DETAILS

- A. Construction documents for WSUS projects shall show scaled plan drawing details for the telecommunications spaces. The details shall show the footprint and location of each of the major components in the room including at least the following:
- Backboards
 - Ladder Racking
 - Work Area
 - UPS Equipment
 - Backbone Cable Routing
 - Entrance Conduits
 - Space for Future Racks
 - Termination Blocks
 - Grounding Busbar
 - Space Reserved for Utility Demarc
 - Racks and Vertical Cable Mgmt
 - Space for other low-voltage systems
 - Entrance Protection Equipment
 - PBX and Voice Mail Equipment
- B. For modifications to existing telecommunications rooms, it may be necessary to provide a demolition plan.
- C. A sample telecommunications room plan diagrams are included in Appendix 6.1.

5.1.7 ELEVATION DIAGRAMS

- A. The Designer shall provide scaled wall elevation details for each TR and ER affected by the project.
- B. For remodel projects, the Designer shall produce digital photographs of each wall depicting the existing conditions where future TRs and ERs will be located. These photos shall be provided with the wall elevation details in the Construction Documents.
- C. The wall elevation details shall show the components that are mounted on the walls in the room, including at least the following:
- Backboards
 - Ladder Racking
 - Cable Slack Loops
 - Grounding Busbar
 - Existing Devices
 - Work Area
 - UPS
 - Entrance Pit
 - Backbone Cable Routing
 - Cable Management
 - Termination Blocks
 - Power Receptacles
 - Entrance Conduits
 - Space for Future Racks
 - PBX and Voice Mail
 - Wall-mounted Electronic Equipment
 - Wall-mounted Swing Racks & Contents
 - Racks and Vertical Cable Mgmt
 - Entrance Protection Equipment
 - Other low-voltage systems
 - Space for Future Equipment
 - Space Reserved for Utility Demarc
- D. Elevation details for each of the telecommunications racks in each TR and ER shall also be provided. Rack elevation details shall show the racks and any components that are mounted on or near the racks including at least the following:
- Patch Panels
 - UPS Equipment
 - Existing Devices
 - Shelves / Drawers
 - Termination Blocks
 - Power Receptacles
 - Space for Future Equipment
 - Electronic Equipment
 - Cable Management
- E. The details shall depict the telecommunications materials that are listed in the specification.

- F. Where a project involves additions to existing racks, the elevation details shall show the existing equipment in the racks and indicate which items are existing, in addition to indicating which items are “new, to be provided under the Contract.”
- G. Examples of rack and wall elevation details are included in Appendix 6.2 and Appendix 6.3.

5.1.8 INTRA-BUILDING BACKBONE SCHEMATIC DIAGRAMS

- A. A schematic diagram of the intra-building television distribution cabling is required, and shall show all passive and active devices. The schematic shall include blocks at each tap and splitter showing the predicted incoming and output signal levels as well as the distances to adjacent devices.
- B. On projects where existing intra-building distribution cabling is to be removed, it may be useful to provide a separate schematic diagram depicting cabling to be demolished.

5.2 Project Manual

- A. The *Instructions for Architects and Engineers Doing Business with Division of Engineering and Architectural Services* (published by the Washington State Department of General Administration) lists requirements for the Project Manual. The *State of Washington Conditions of the Agreement* (also published by the Washington State Department of General Administration) lists additional requirements for the Designer.
- B. The Project Manual shall contain a summary of the telecommunications work on the project, a description of the demolition requirements (if applicable), and a discussion of the utility coordination requirements.
- C. In addition to these requirements, the Project Manual shall contain the following items as described below:
 - Horizontal Cabling Labeling Spreadsheet
 - Fiber Link-Loss Budget Analyses
 - Cutover Plans

5.2.1 SPECIFICATIONS

5.2.1.1 WSUS TELECOMMUNICATIONS CONSTRUCTION GUIDE SPECIFICATION

- A. The WSUS Telecommunications Construction Guide Specification (TCGS) is a *guide* specification as opposed to a *master* specification. It does not include an exhaustive listing of all possible products or installation methods that could be employed in a telecommunications infrastructure project.

- B. The TCGS is an example of a specification that shall be used for an infrastructure replacement project or for a new facility project. It has verbiage that identifies issues that the Designer shall consider throughout the adaptation process. The Designer shall adapt the sections in the TCGS to the particular requirements of the given project.
- C. The Designer shall directly edit the TCGS for use on each project. The Designer shall notify the WSUS ITPM where changes or additions to the specifications are desired. Edits to the documents shall be performed with the “Revision Tracking” features activated. At the various project milestones when the documents are submitted to WSUS for review, the specifications shall be printed showing the revision markings.
- D. The Designer shall be responsible for adding any necessary content to the specification that is applicable to the project and not already contained in the TCGS.
- E. Please refer to the more detailed instructions contained in the TCGS, both in the Preface of that document as well as in the “hidden text” comments contained in the electronic files.

5.2.1.2 COMMON SPECIFICATION SECTIONS

There are several specification sections that are commonly used for telecommunications systems, or which contain content that supports telecommunications functionality.

Sections typically provided by the architect, but requiring Designer input:

- 099100 – Painting
- 078413 – Penetration Firestopping

Sections typically provided by the Telecommunications Engineer:

- 270500 – Common Work Results for Communications
- 270526 – Grounding and Bonding for Communications Systems
- 270528.29 – Hangers and Supports for Communications Systems
- 270528.33 – Conduits and Backboxes for Communications Systems
- 270528.36 – Cable Trays for Communications Systems
- 271100 – Communications Equipment Room Fittings
- 271300 – Communications Backbone Cabling
- 271500 – Communications Horizontal Cabling
- 271600 – Communications Connecting Cords, Devices, and Adapters
- 273200 – Voice Communication Telephone Sets
- 338126 – Communications Underground Ducts, Manholes, and Handholes
- 338200 – Communications Distribution
- 338243 – Grounding and Bonding for Communications Distribution

5.2.2 CUTOVER PLAN

The Designer shall provide a detailed cutover plan that is coordinated with other disciplines on the project as well as with WSUS data and telephone equipment cutover requirements. Verbiage describing the sequence of work tasks to accomplish the cutover shall be provided in this section. Limitations on the permissible downtime allowed and temporary service arrangements shall be discussed in the cutover plans.

The Cutover Plan shall also include a rollback strategy to enable reversion to the existing system if a problem develops that is serious enough to render cutover unfeasible.

Not all projects will require a cutover plan.

5.2.3 FIBER LINK-LOSS BUDGET ANALYSIS

- A. The Designer shall provide (in the Construction Documents) a link-loss budget analysis for each fiber optic cable.
- B. The link-loss budget analysis shall be formatted as shown in Appendix 6.4. Upon request, WSUS will provide an electronic spreadsheet file to be used as a template.

5.3 Record Drawings and Documentation

The *Instructions for Architects and Engineers Doing Business with Division of Engineering and Architectural Services* (published by the Washington State Department of General Administration) lists requirements for Record Drawings and submittals. The following requirements related to Record Drawings and submittals are **in addition** to the requirements listed in *Instructions for Architects and Engineers Doing Business with Division of Engineering and Architectural Services*:

5.3.1 RECORD DRAWING CONTENT

- The Record Drawings shall show the identifiers for the telecommunications equipment and cabling as constructed.
- The Record Drawings shall show actual measured signal levels and lengths of television distribution cabling as constructed.

5.3.2 RECORD DRAWING DELIVERABLES

The following shall be delivered to the WSUS FSPM, the second copy of which shall be given to the ITPM:

- Two copies of a CDROM containing editable 2D AutoCAD drawings (with all xrefs bound to the drawing) of the telecommunications plans, elevations and details, in addition to the Revit or BIM model files.
- Two copies of a CDROM containing the digital photographs taken by the Designer during the project.

6 Appendices

6.1 Sample Telecommunications Room Plan Details

Below are sample plan details for several sizes of telecommunications rooms. The Designer shall provide similar details and information for each telecommunications room and equipment room affected by the project. This information shall be provided in the Construction Documents.

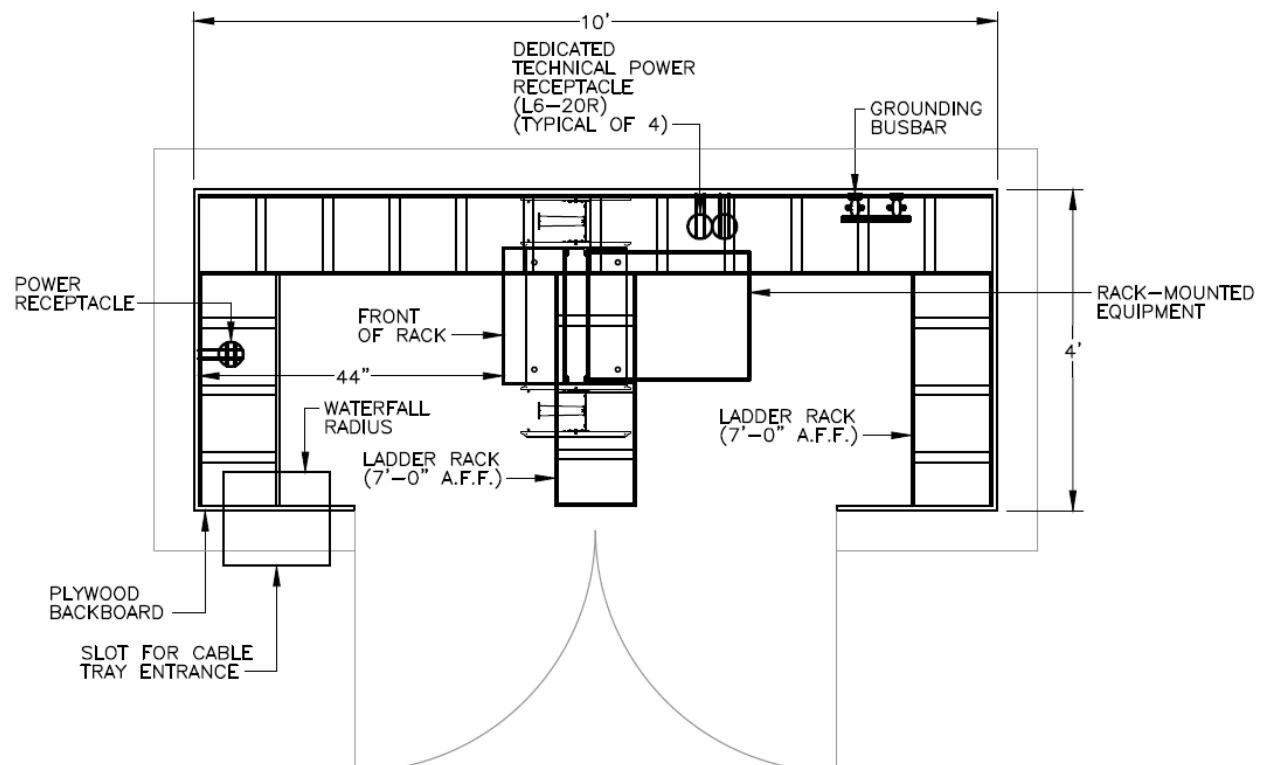
These sample plan details have been pre-approved for use at WSUS. The Designer shall use this layout wherever appropriate and shall discuss project-specific alternatives with the ITPM.

The room dimensions shown are considered to be acceptable minimums.

6.1.1 IDF: 1 RACK REACH IN – 10' x 4'

This example is suitable for a Day-1 design with a maximum of 96 horizontal cables (leaving room for future growth).

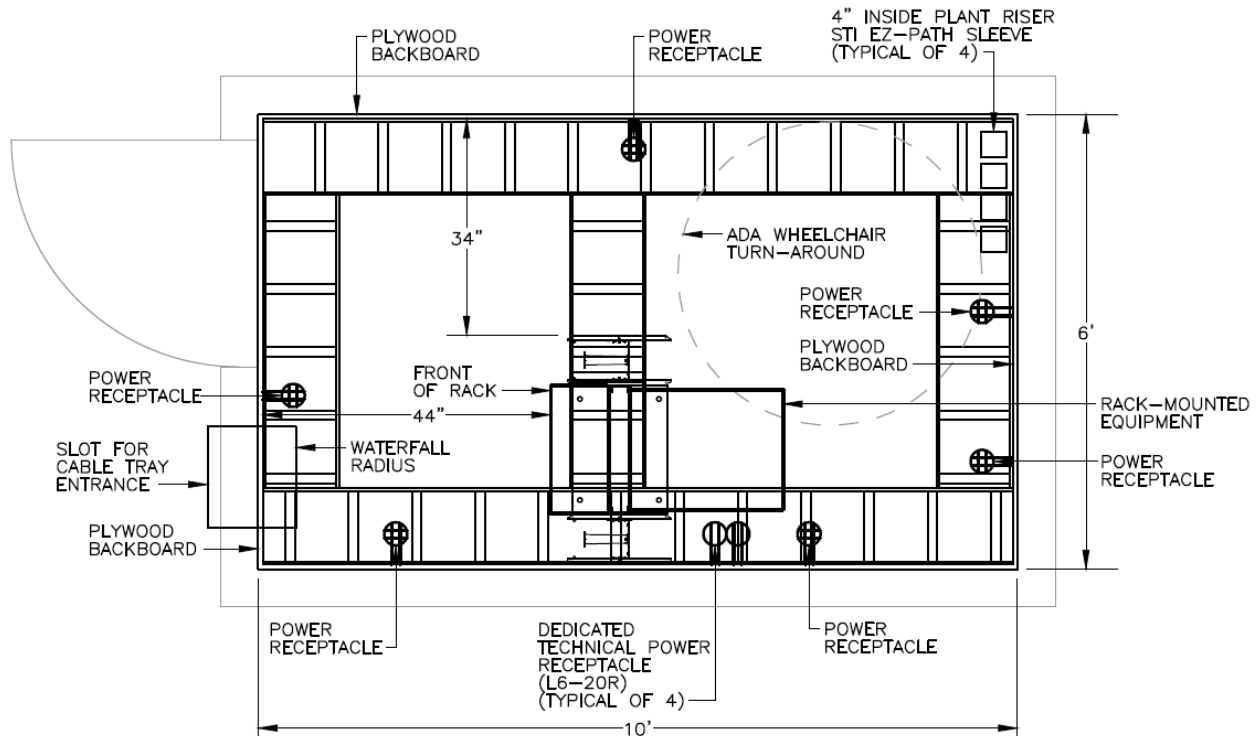
A one-rack room is rarely adequate, because it has very limited space for future equipment or cabling to be added. Therefore, it shall only be used as a last resort, and then only with the approval of the ITPM.



6.1.2 IDF: 1 Rack – 10' x 6'

This example is suitable for a Day-1 design with a maximum of 96 horizontal cables (leaving room for future growth).

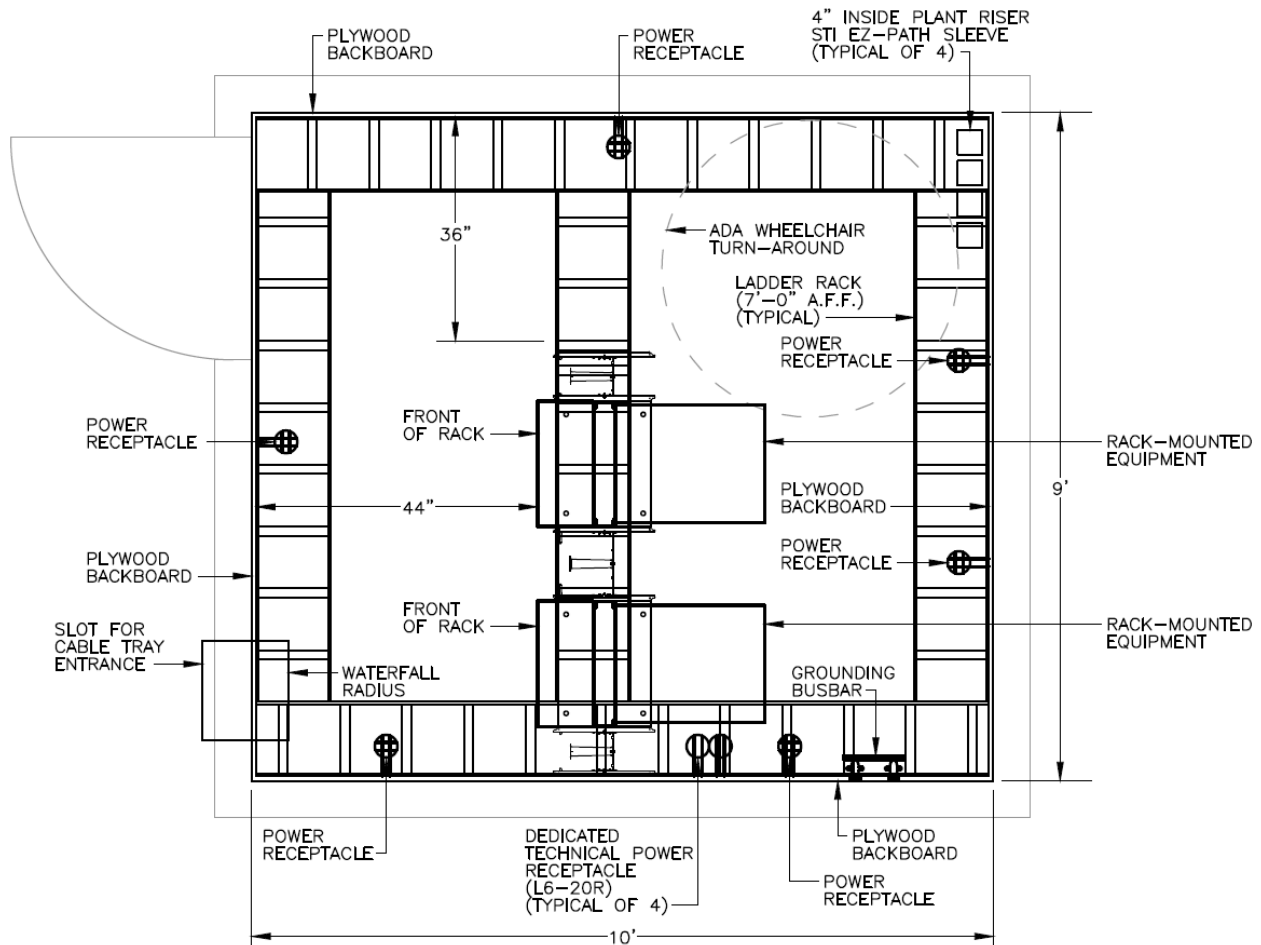
A one-rack room is rarely adequate, because it has very limited space for future equipment or cabling to be added. Therefore, it shall only be used as a last resort, and then only with the approval of the ITPM.



6.1.3 IDF: 2 Racks – 10' x 9'

This example is suitable for a Day-1 design with a maximum of 192 horizontal cables (leaving room for future growth).

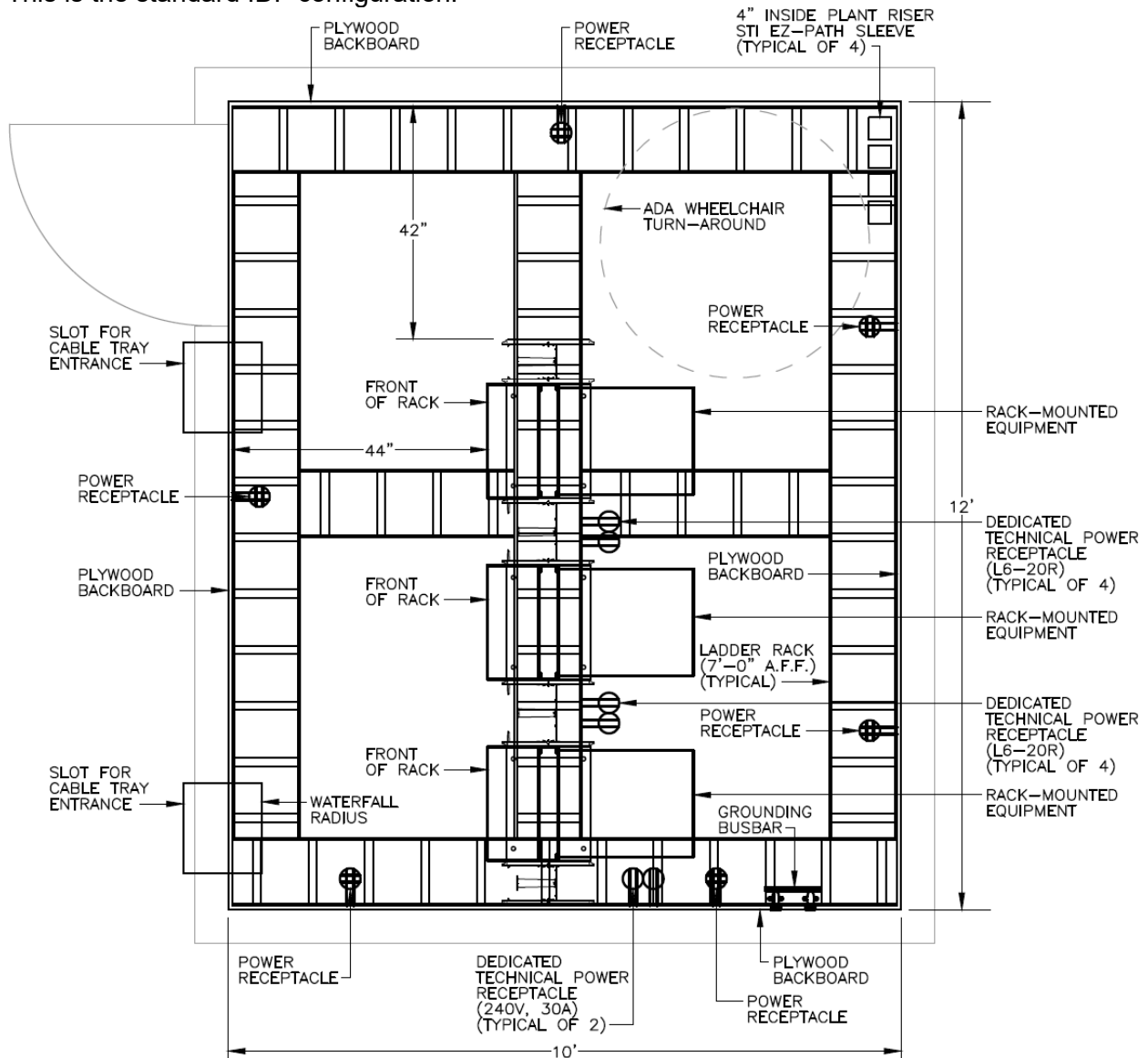
A two-rack room is rarely adequate, because it has very limited space for future equipment or cabling to be added. Therefore, it shall only be used as a last resort, and then only with the approval of the ITPM.



6.1.4 IDF: 3 RACKS – 10' x 12'

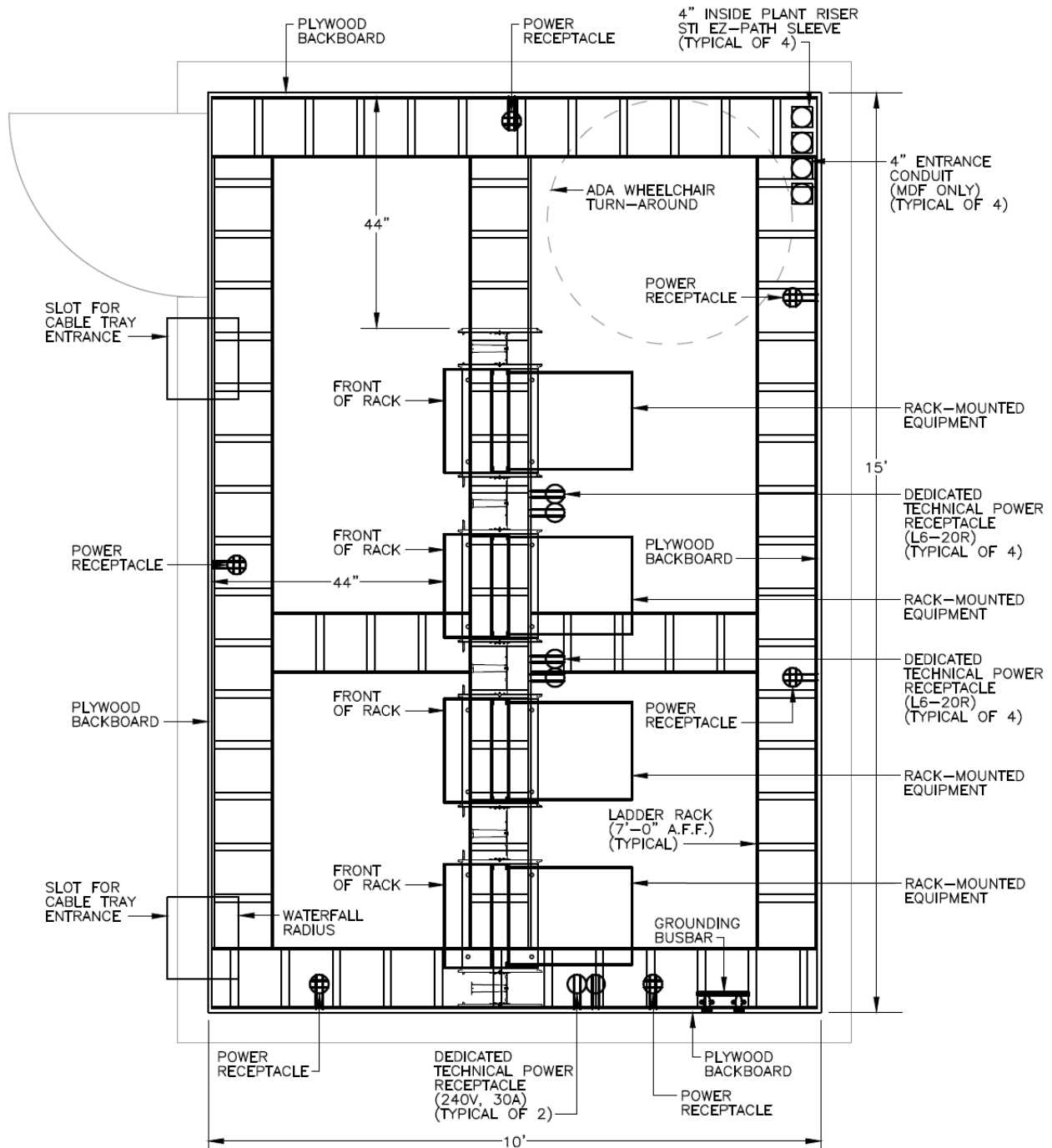
This example is suitable for a Day-1 design with a maximum of 288 horizontal cables (leaving room for future growth).

This is the standard IDF configuration.



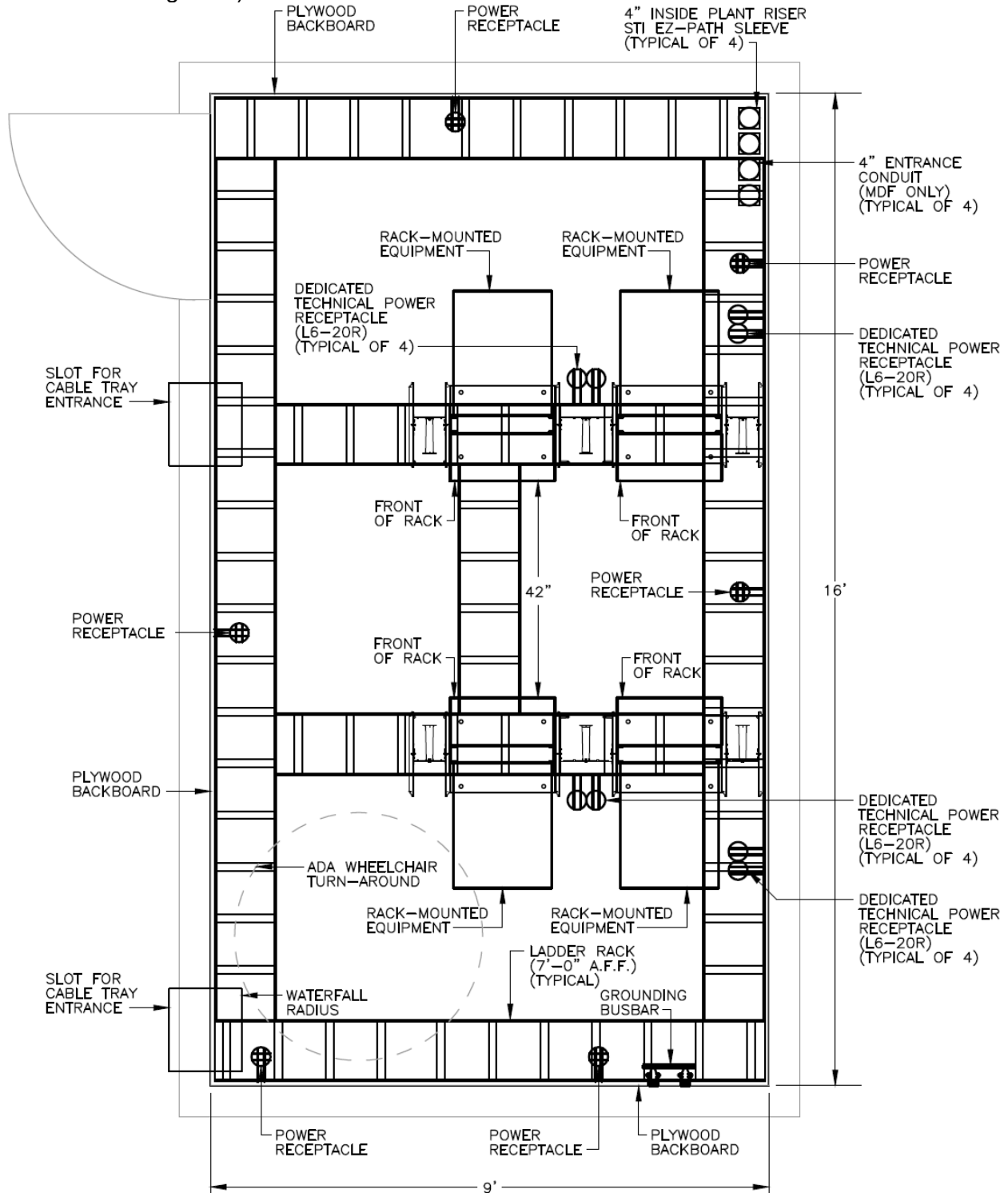
6.1.5 IDF / MDF: 4 RACKS – 10' x 15'

This example is suitable for a Day-1 design with a maximum of 336 horizontal cables (leaving room for future growth).



6.1.6 IDF / MDF: 4 RACKS (2 Rows) – 9' x 16'

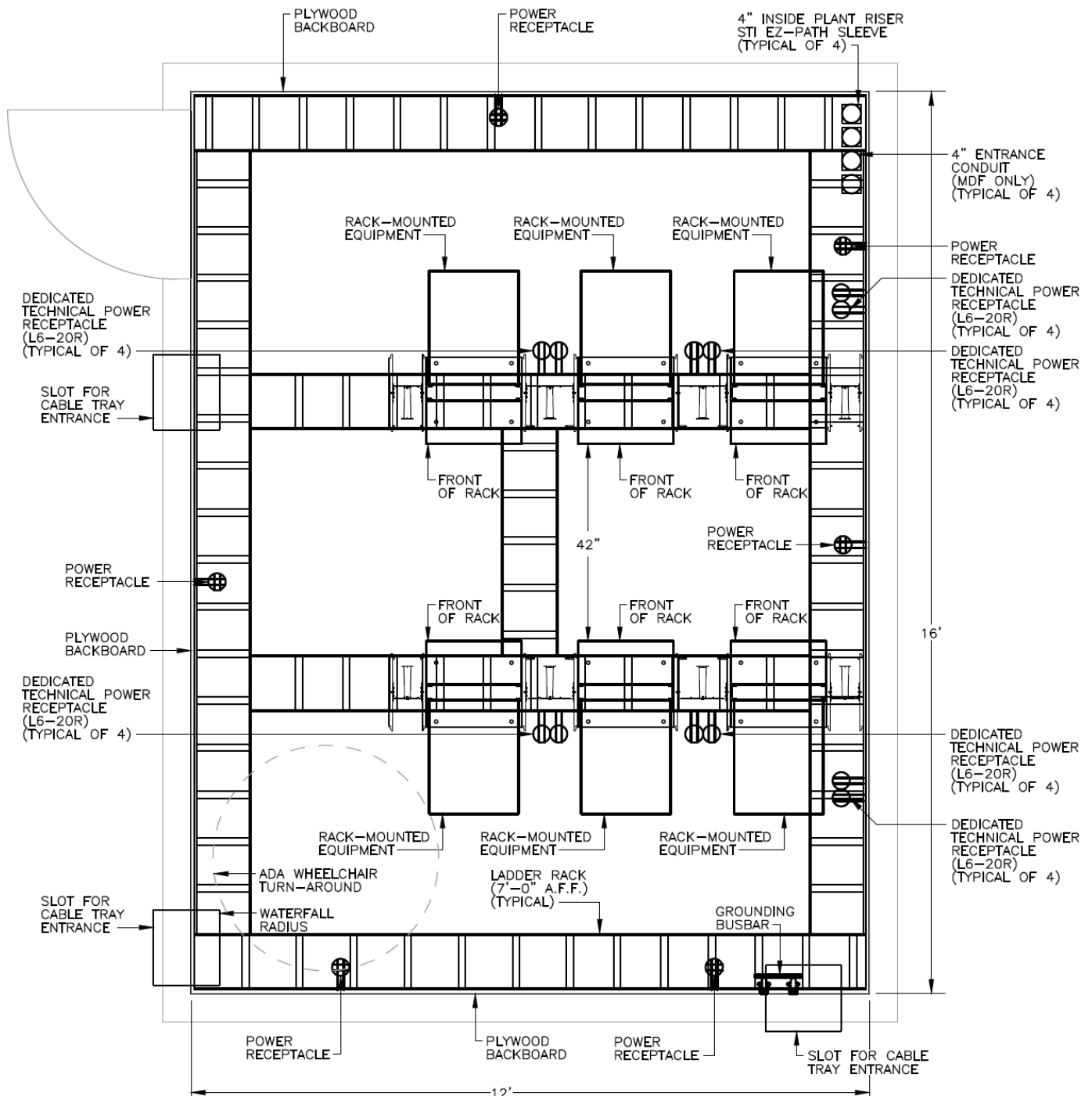
This example is suitable for a Day-1 design with a maximum of 336 horizontal cables (leaving room for future growth).



6.1.7 MDF: 6 Racks (2 Rows) – 12' x 16'

This example is suitable for a Day-1 design with a maximum of 504 horizontal cables (leaving room for future growth).

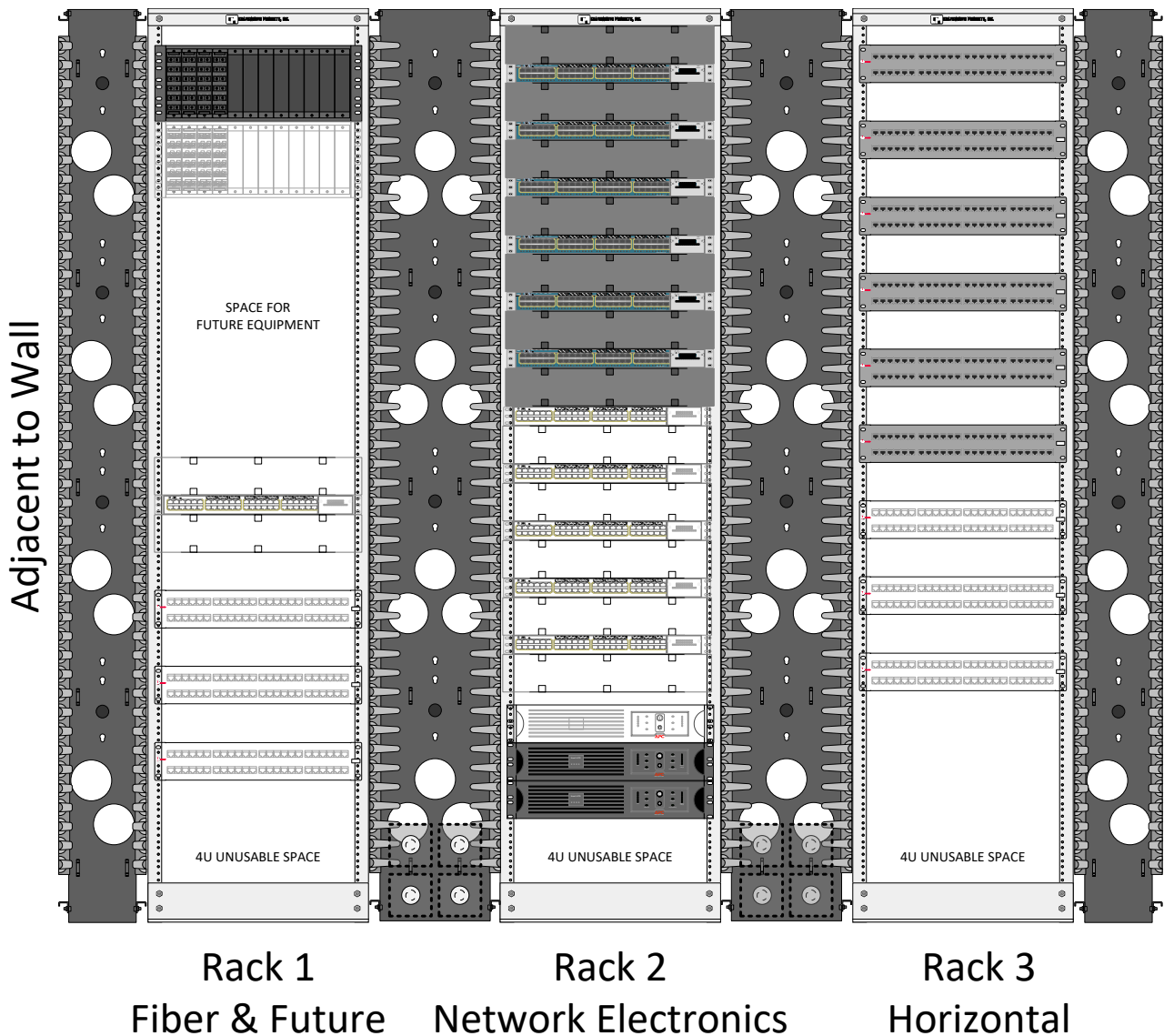
This is the standard MDF configuration.



6.2 Sample Rack Elevation Detail

This page shows a sample scaled rack elevation detail. The Designer shall provide similar information for each new or existing telecommunications rack affected by the project.

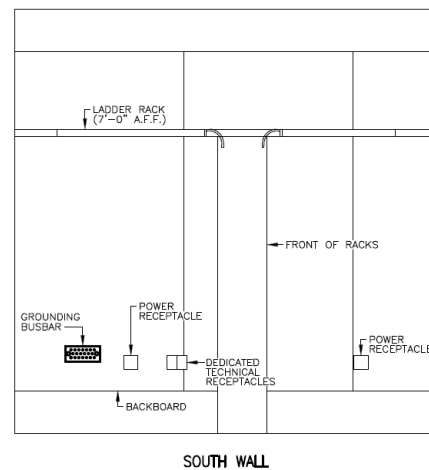
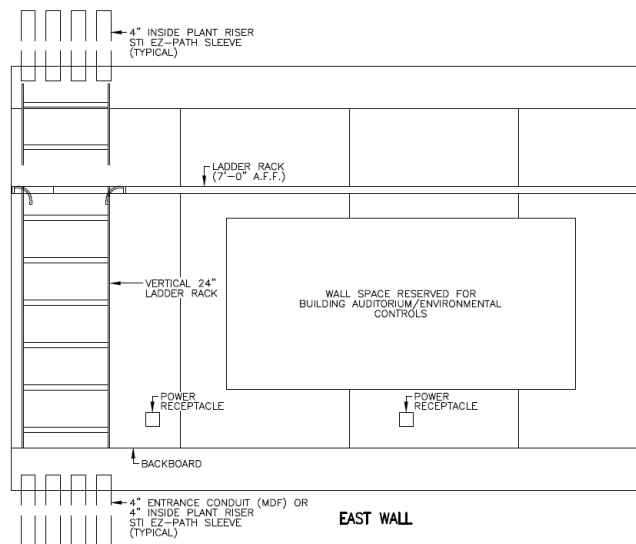
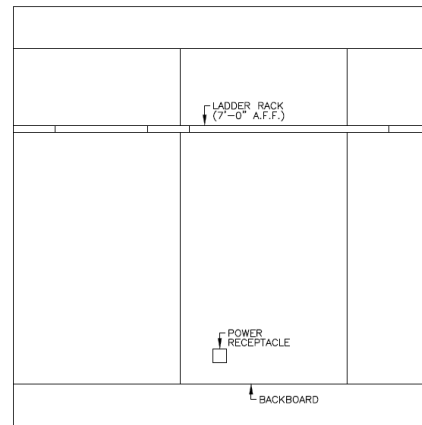
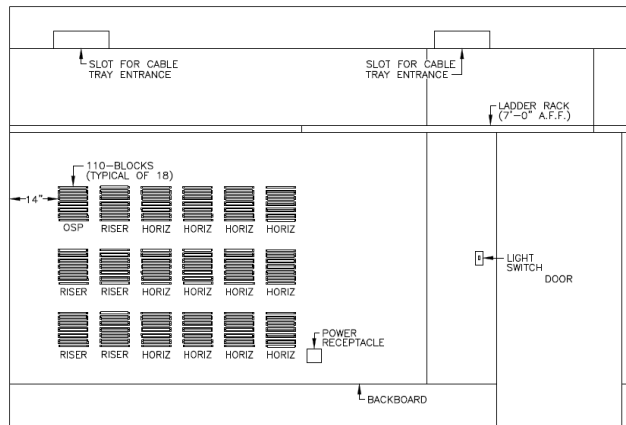
This information shall be provided either as a portion of the Project Manual or on the drawings, and shall be considered part of the Construction Documents.



6.3 Sample Wall Elevation Detail

This page shows a sample scaled wall elevation detail. The Designer shall provide similar information for each new or existing telecommunications room wall affected by the project.

This information shall be provided either as a portion of the Project Manual or on the drawings, and shall be considered part of the Construction Documents.



6.4 Sample Fiber Optic Link-Loss Budget Analysis

The following is a sample Fiber Optic Link-Loss Budget Analysis that the Designer shall use for each new fiber optic cable designed in the project. The Designer shall submit the completed link-loss budget analyses to WSUS in both electronic and paper forms. Upon request, WSUS will provide an electronic spreadsheet of this form to be used as a template.

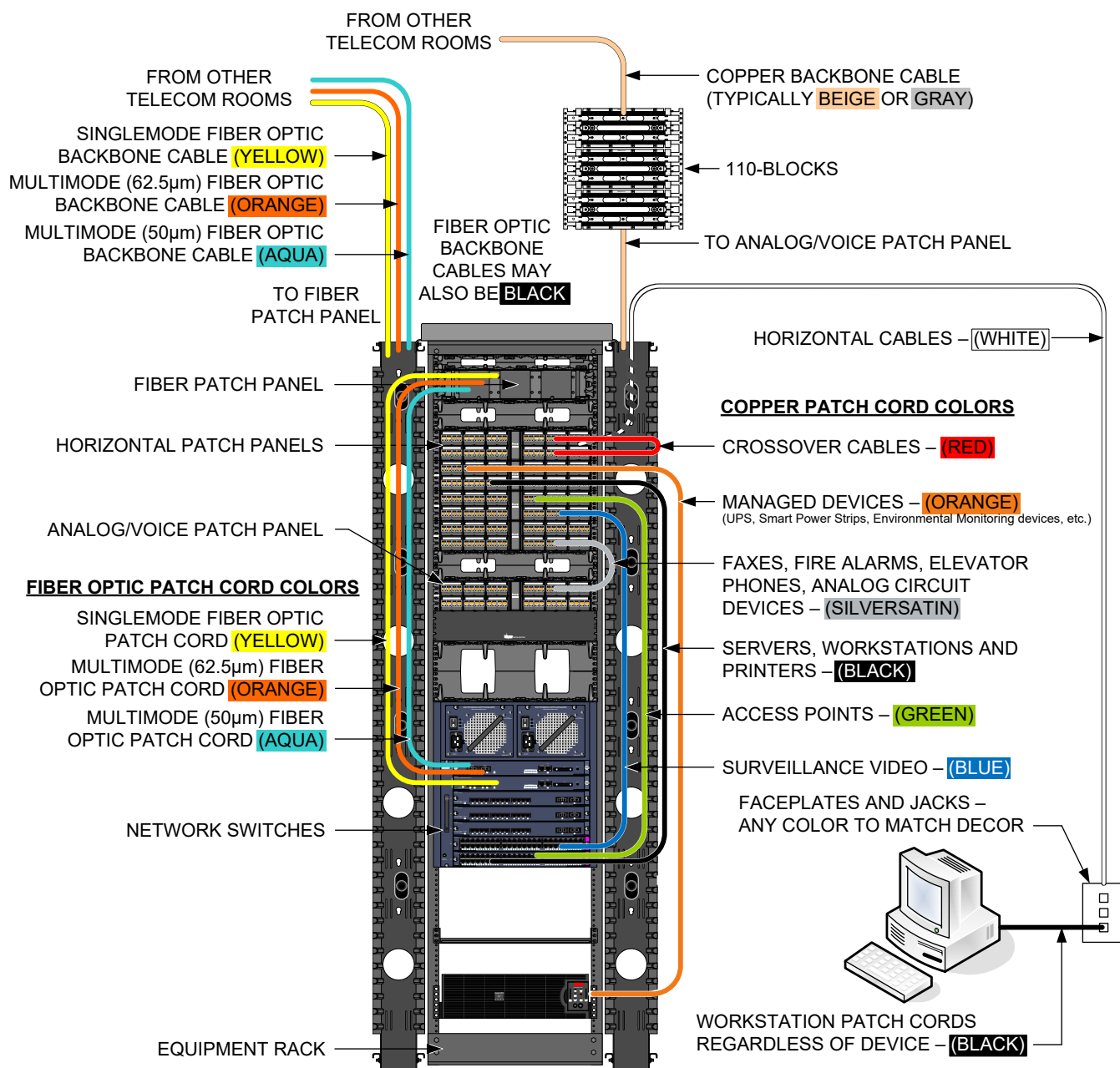
Cable ID:	Enter Cable ID Here				# of MM Strands	
From:	Enter MDF/Building Name Here				# of SM Strands	
To:	Enter IDF/Building Name Here					
		MM 850	MM 1300	SM 1310	SM 1550	
Passive Cable System Attenuation						
Fiber Loss at Operating Wavelength	Cable Length (in kilometers)					km
	x Attenuation per km	x	x	x	x	dB/km
	= Total Fiber Loss	0.00	0.00	0.00	0.00	dB
Connector Loss (Excluding Tx & Rx Connectors)	Number of Connector Pairs	2	2	2	2	pairs
	x Individual Connector Pair Loss	x	x	x	x	dB/pair
	= Total Connector Loss	1.00	1.00	1.00	1.00	dB
Splice Loss	Number of Splices					splices
	x Individual Splice Loss	x	x	x	x	dB/splice
	= Total Splice Loss	0.00	0.00	0.00	0.00	dB
Other Components Loss	Total Components Loss					dB
Total Passive Cable System Attenuation	Total Fiber Loss	0.00	0.00	0.00	0.00	dB
	+ Total Connector Loss	+ 1.00	+ 1.00	+ 1.00	+ 1.00	dB
	+ Total Splice Loss	+ 0.00	+ 0.00	+ 0.00	+ 0.00	dB
	+ Total Components Loss	+ 0.0	+ 0.0	+ 0.0	+ 0.0	dB
	= Total System Attenuation	1.00	1.00	1.00	1.00	dB
		MM 850	MM 1300	SM 1310	SM 1550	
Link Loss Budget						
From Manufacturer's Specifications	Average Transmitter Output	-18.0	-18.0	-18.0	-18.0	dBm
	Receiver Sensitivity (10 ⁹ BER)	-31.0	-31.0	-31.0	-31.0	dBm
System Gain	Average Transmitter Power	-18.0	-18.0	-18.0	-18.0	dBm
	- Receiver Sensitivity	- -31.0	- -31.0	- -31.0	- -31.0	dBm
	= System Gain	13.00	13.00	13.00	13.00	dB
Power Penalties	Operating Margin	2.0	2.0	3.0	3.0	dB
	+ Receiver Power Penalties	+ 0.0	+ 0.0	+ 0.0	+ 0.0	dB
	+ Repair Margin	+ 0.6	+ 0.6	+ 0.6	+ 0.6	dB
	= Total Power Penalties	2.60	2.60	3.60	3.60	dB
Link Loss Budget	System Gain	13.00	13.00	13.00	13.00	dB
	- Power Penalties	- 2.60	- 2.60	- 3.60	- 3.60	dB
	= Total Link Loss Budget	10.40	10.40	9.40	9.40	dB
		MM 850	MM 1300	SM 1310	SM 1550	
Performance						
System Performance Margin	Link Loss Budget	10.40	10.40	9.40	9.40	dB
	- Passive Cable System Attenuation	- 1.00	- 1.00	- 1.00	- 1.00	dB
	= System Performance Margin	9.40	9.40	8.40	8.40	dB

Users of this spreadsheet shall verify prior to use that the parameters and calculations are appropriate for the project, equipment and materials that are used.

6.5 Cable Color Scheme

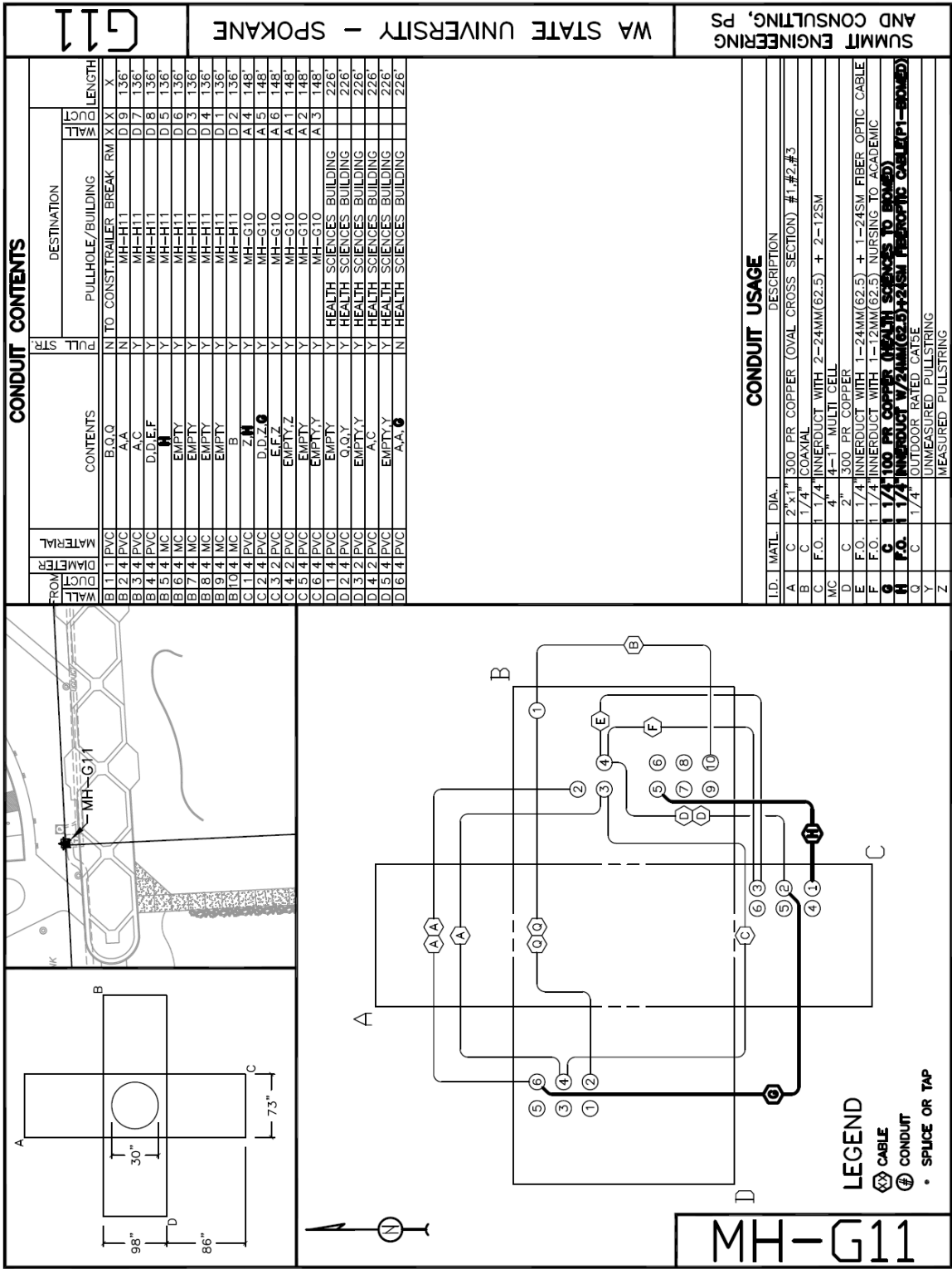
The following graphic depicts the approved cable color scheme for WSUS projects:

****Note, For Copper Patch Cord Colors, they shall be black (disregard color diagram)**



6.6 Maintenance Hole Butterfly Diagram

The following drawing is a sample butterfly diagram for an outside plant maintenance hole:



6.7 Glossary

A/E	Architect / Engineer
ACPM	Access Control Project Manager
AVCGS	Audio/Visual Construction Guide Specification
AVDG	Audio/Visual Design Guide
AVPM	Audio/Visual Project Manager
CDF	Controlled-density fill
CGS	Construction Guide Specification
CGSP	Construction Guide Specification Preface
CMU	Concrete masonry unit
EMI	Electromagnetic interference
ESS	Electronic Safety and Security
FF&E	Furniture, fixtures and equipment
FSPM	Facilities Services Project Manager
GC/CM	General Contractor/Construction Manager
HC	Horizontal cross-connect
HCP	Horizontal connection point
IC	Intermediate cross-connect
IDF	Intermediate Distribution Frame (secondary telecommunications rooms)
ISP	Inside plant
ITPM	Information Technology Project Manager
MC	Main cross-connect
MAC	Moves, adds or changes
MDF	Main Distribution Frame (main telecommunications room in the building)
O.D.	Outside Diameter
OSP	Outside plant
PDU	Power distribution unit
PII	Personally identifiable information
POE	Power over Ethernet
RCDD	Registered Communications Distribution Designer
RFI	Radio frequency interference
SVR	Standards Variance Request
TCGS	Telecommunications Construction Guide Specification
TDDG	Telecommunications Distribution Design Guide

TGB	Telecommunications grounding busbar
TIDG	Technology Infrastructure Design Guide
TPM	Technology Project Manager
TR	Telecommunications room
UTC	Undercarpet telecommunications cabling
UTP	Unshielded twisted pair
WAP	Wireless access point