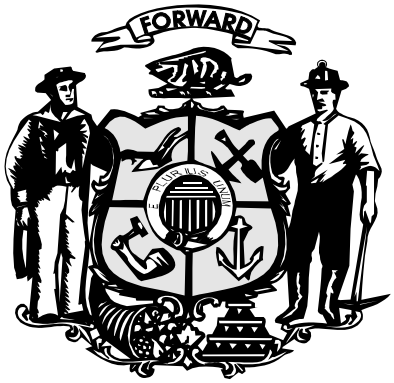

Communications Structured Cabling System Standards & Design Guidelines

Revised 11/07/16

STATE OF WISCONSIN
DEPARTMENT OF ADMINISTRATION
DIVISION OF FACILITIES DEVELOPMENT

101 East Wilson Street
P.O. Box 7866
Madison, WI 53707-7866

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Communications Structured Cabling System

Standards & Design Guidelines

Table of Contents

I. INTRODUCTION

This manual establishes standards and guidelines for the design, construction and renovation of State of Wisconsin facilities. These standards and guidelines were developed from past Division of Facilities Development (DFD) and agency experience with the operation and maintenance of State communications systems.

The purpose of this document is to provide A/E firms and agency personnel with the information necessary to design and specify a Structured Cabling System for DFD projects supporting a wide range of communications systems. These guidelines concentrate on new building environments and existing buildings under consideration for renovation of wiring plants. Existing facilities can also benefit by following these guidelines when adding new applications to their existing wiring plants. The document can also be used by agencies in developing a usable program statement (scope of work) for new projects.

The focus of these documents is Division 27 work. References to other division of work are also included, however. The Division 27 designer should work closely with designers of other divisions of work – especially Division 26 - to ensure an integrated design that provides adequate equipment space, pathways, electrical power and lighting, and mechanical system support for the project.

These guidelines define minimum requirements but allow for customization to meet specific requirements for each project. The resulting design should provide full functionality for the agencies current applications and provide the flexibility that will enhance future opportunities to meet future requirements in the categories of voice, data, audiovisual and security systems.

It should be noted that various State agencies maintain their own site-specific guidelines. The consultant shall check with the agency to determine where such guidelines exist that would apply to their scope of work. Agency guidelines shall supplement these DFD guidelines and the DFD master specifications. Conflicts between the guidelines shall be discussed with DFD and the agency to achieve resolution. Deviations from these guidelines are not permitted without approval from DFD.

It should also be understood that there likely are situations requiring special design features not covered in these guidelines. It is the responsibility of the consultant or agency personnel to discuss such issues with DFD before incorporating them into the documents for construction.

The requirements of these guidelines may exceed what is required by applicable code. In no case is it intended that these guidelines allow designs not conforming to applicable codes.

These guidelines remain under continuous scrutiny and change. Changes will result from the overall advancement of technology and industry practices, from further experience in State facilities, and from the comments of consultants, contractors, and agency personnel. Consultants and agency personnel should routinely review these guidelines and the DFD master specifications for Division 27 and related divisions of work as they apply to each particular project.

- For the latest version of this document and other DFD master specification documents, from the DFD Website, click on “Document Library & Master Specs", then select the link “Master Specifications / Design Guidelines”. On that page, select the link “27 - Communications”.

Compliance with Laws and Regulations: Readers of this document should review the documents in the DFD Master Specifications, Division 1, General Conditions, General Requirements, and referenced statutes, codes, and zoning rules.

Codes and Standards (plus update bulletins and errata) applicable to Communications Structured Cabling include:

General

- ANSI/IEEE C2 - National Electrical Safety Code
- SPS Chapter 316 – Wisconsin Dept. of Safety and Professional Services Electrical Code

Structured Cabling and Infrastructure

- TIA-568.0-D, -568.1-D, -568-C.2, -569-C, -606-B and TIA standards referenced therein.
- ANSI/TIA-862-B – Structured Cabling Infrastructure Standard for Intelligent Building Systems
- IEEE/ANSI 142-1982 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- ICEA publication S-80-576-2002
- TIA-526-14 and -526-7

- TIA-607-C - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

Note that these guidelines and referenced documents are dynamic and subject to change. Designers are strongly encouraged to confer with the DFD Engineer to confirm content.

II. A/E RESPONSIBILITIES

Refer to DFD "Policy and Procedure Manual for Architects/Engineers and Consultants". This is available at the DFD Website under "AE News & Policy and Procedure Manual".

III. BID DOCUMENTS

A. General

On plans and specs, use terminology matching DFD contract documents to identify contractor(s).

Use "General Prime Contractor" or "GPC" rather than "Lead Contractor", "General Contractor", "G.C.", etc..

Use care in references to various installers that are included in Electrical Contractor scope of work. All Division 26, 27 and 28 work is the responsibility of the Electrical Contractor under DFD Bidding structure. Where responsibilities for various sub-systems or division of work are to be included for reasons of installer qualifications or as an aid to the EC in apportioning work, include general note(s) explaining that "the delineation of work is suggested as an aid to the Electrical Contractor in assigning responsibilities".

Use terminology that clarifies installer responsibilities. For example, for work that relates to:

- Power, lighting and pathways, use "Division 26 Installer".
- Telecommunications, use "Telecommunications System Installer".
- Audiovisual, use "AV System Installer".
- Electronic Security, use 'Division 28 Installer", "Electronic Security System Installer", "Card Access System Installer" and/or "Video Surveillance System Installer" as applicable.

Add to the description of each installer, an explanation of this installers responsibilities.

B. Coordination With Other Divisions

Coordinate all communications systems with the structural, civil, architectural, electrical and mechanical plans. Take care to consider all communication equipment and spaces.

Coordinate with Foundation Plan(s) annotate as applicable to show required penetrations to accommodate power and communications conduit entry to the building as applicable.

The architectural and communications designs shall be integrated so as to provide adequate space to install and maintain all equipment.

Check the ceiling design for telecommunication equipment rooms. A room open to structure (e.g. no drop ceiling) is preferred. Confirm with DFD if drop ceiling is proposed by the architectural team.

Show all smoke partitions and fire-rated walls (and their hourly ratings) on the drawings, or provide a note to refer to the architectural drawings for their identification.

Sleeves and openings for communications cabling shall be coordinated with the other consultants to determine the location, clearances from other trades, structural concerns, etc. These concerns shall be addressed during the design phase.

Adequate ventilation or cooling shall be provided for telecommunications equipment rooms. As a minimum, ducted fresh air should be provided. Coordinate ventilation and cooling requirements with the architect and mechanical designer.

Adequate electrical power and lighting shall be provided for telecommunications equipment rooms. Coordinate electrical requirements with the architect and electrical designer.

C. Integration with Other Systems

In the project's programming stage, it is important to coordinate the telecommunications systems and the required infrastructure requirements related to these systems. This is especially critical for all design/build projects.

Electrical
For Electrical System Standards & Design Guidelines, mouse-click on Division “26” and then on “EL Guides.doc". Electrical guidelines specific to Communications Systems are included in that document. Topics include pathways (raceway, boxes, cable tray, etc.), power and lighting of equipment spaces, and grounding infrastructure.

Coordinate plans and specifications for Raceway & Boxes (ref. specification Section 26 05 33), especially those relating to Floor Boxes and Poke-through fittings. Coordinate with Div. 26 designer to confirm dimensions, construction, device capacity, conduit feed (quantity, dimensions, where routed), etc.

Mechanical
Coordinate with mechanical system designer regarding Division 23 content relating to ventilation and/or cooling of Telecommunications or AV Rooms to maintain acceptable temperature. DFD guidelines call for temperature in a Telecommunications or AV Rooms to be kept between 65- and 80-degrees F, 24 x 7 x 365.

Consider all planned equipment plus capacity for growth.

A/E should be prepared to provide load assumptions and calculations to DFD Electrical and Mechanical engineers during document review phases.

Fire Alarm Systems
For Fire Alarm System Standards & Design Guidelines, mouse-click on Division “28” and then on “FA Guides.doc".

Confirm communications requirements with fire alarm system designer

Audiovisual Systems
A consultant with expertise in the area of audiovisual system cabling and electronics shall have responsibility for design of these systems. These systems often have unique communications requirements. Confer with AV system designer and DFD Engineer during design development.

Electronic Security Electronics Systems
A consultant with expertise in the area of security system cabling and electronics shall have responsibility for design of these systems. These systems often have unique communications requirements. Systems might include:

- Access Control
- Video Surveillance
- Personal Body Alarm
- Intrusion Detection (Use of motion sensors, video motion detectors, glass-break sensors, etc.).
- Perimeter Detection.
- Duress Alarms
- Others

Confer with Security System designer and DFD Engineer during design development.

Other Systems
There may be other systems that include a communications function. Confer with respective system designer(s) and DFD Engineer during design development. Systems might include:

- Security Door/Intercom Control and Monitoring
- Public Address / Paging.
- Emergency Phones
- Others

D. Drawings – General Requirements

General
Communications construction drawings shall show all necessary cabling and equipment for the project. The communications construction drawings shall be designed so that the contractor is able to use the proper combination of materials, techniques, and manpower to accomplish the overall installation.

Refer to DFD CAD STANDARDS INSTRUCTION MANUAL (available on the DFD website) fir detailed instructions for development of drawings for DFD projects.

The use of "COMMUNICATIONS" in the sheet titles is suggested. That designation, matches CSI Master Format description of construction discipline and is inclusive of voice, data (network), audiovisual and various distributed systems (paging, clocks, sound-masking, etc.). "TELECOMMUNICATIONS", "INFORMATION TECHNOLOGY" (or simply "TECHNOLOGY"), and "LOW-VOLTAGE SYSTEMS" are limited in scope and/or do not reflect bid document structure and construction industry terminology.

Where not integrated with "E" series sheets, Communications drawings should use a "Q" designation. "T" should not be used as this is reserved for the Tile sheet(s). Audiovisual may use "AV".

Where the project includes work at multiple buildings, it is acceptable to include a building designator in the sheet number.

The first number following the discipline letter (e.g. "E" or "Q") shall identify the discipline's drawing type (i.e. floor plans, sections, elevations, schedules, details, etc.). A/E's may use their own numbering plan for this numbering. The following outline is suggested:

- Title Sheet (T001)
- Symbols & Abbreviations
- Site Plans
- Plans
- Enlarged Plans
- Schematics/One-lines
- Details
- Schedules

The outline structure should be the same for all disciplines.

Terminology

Edit drawings to use terminology consistent with what is used in the specification.

The meaning of all Acronyms used should be clearly explained on the Symbols & Abbreviations sheet.

In notes to avoid ambiguity as to contractor responsibilities restructure sentences to be more direct; e.g. using "active voice". For example:

- Use "DEMOLISH" rather than "IS TO BE DEMOLISHED".
- Use "COORDINATE" rather than "CONTRACTOR SHALL COORDINATE".
- Use "PROVIDE [PRODUCT]" rather than "[PRODUCT] SHALL BE PROVIDED" or "CONTRACTOR SHALL SUPPLY AND INSTALL".
- Use "DISCONNECT AND REMOVE [ITEM]" rather than "[ITEM] IS TO BE DISCONNECTED AND REMOVED"

Product Descriptions

Per DFD Policy governing drawing and specification content, only generic terms are to be used on drawings.

Manufacture and model number may be used ~in specifications~ as a basis-of-design example or where sole-source specification is allowed by the DFD Project Manager and a Class 1 Notice is included for each such product.

All pertinent performance and features must be included in the specification.

Technical content of the section will be the basis on which equals are determined. Features of a "basis-of-design" product not include in the technical language may not be considered.

Symbols and Abbreviations

Include only symbols for equipment actually installed on the project. Edit out all other symbols.

On Equipment Outlet symbol(s) include attributes necessary to clarify configuration, number of cables, mounting height/location, application, etc. as applicable. The DFD has no standard for this symbol type.

- Use "W" designation to indicate an "Outlet for Wall-mounted Telephone Set".

- Use “WAP” or “AP” to indicate an “Outlet for Wireless Access Point”. Include “WAP BY OWNER” in the description.

Suggest that reference to specification Section 26 05 33 be included to direct the contractor to language regarding rough-in requirements for various outlet types.

Site Plans
Show major pathway routes for communications services including all underground or overhead services, ductbanks, manholes, and other important feature. Include all conduit requirements from signal manholes to telecom entry points for services such as fire alarms reporting, security reporting, voice/data/video service, campus automation system connection, multi-conductor exterior lighting control, etc.

Floor Plans
Show all Equipment Outlets (EO), Equipment Rooms (backboards, racks, cable runway), major penetrations (floor and wall sleeves and conduits) and major cable pathways (cable tray, conduit).

Confirm that the required power circuits and communications cabling provisions for security, and other miscellaneous systems required by project program are shown.

Equipment Room Enlarged Plans and Rack Elevations
DFD recommends that enlarged plans of Equipment Rooms be included. Show equipment rack placement, cable runway routing, cable tray and conduit entry points, grounding busbars, wall-mounted connectivity and equipment, etc..

Show Equipment Rack(s) to-scale and consider required clear space for access, door swing, etc.

DFD recommends that Rack Elevation drawings be included. Show connectivity and equipment.

Include work by the contractor and space allocated for work by others”.

Schematics / One-line Diagrams (Risers)
Provide one-line schematic (“riser”) diagrams to depict the communications backbone cabling arrangement for a project. This applies to all new building distribution systems and additions/changes to existing building distribution systems.

Grounding and Bonding
Detail the requirements of the grounding system in the drawings and specifications. References only to the NEC or TIA are not sufficient.

Include Grounding Schematic (riser) and applicable details. Coordinate preparation of the schematic with the electrical system designer. Grounding infrastructure is typically installed by the Division 26 contractor.

Bond each rack to the TGB via a separate conductor. Alternately, a single bonding conductor may be run from the TGB to the row of racks and a conductor for each rack tapped off of the single Bonding conductor.

Construction Details
Provide construction details on drawings to specify construction requirements.

Provide plan view, elevation and/or detail drawings to cover all communications and other related low-voltage equipment, equipment rack elevations, Equipment Outlet faceplate configurations. Provide cross sections and details of the manholes and ductbanks.

Equipment Schedules
Sometimes used in Structured Cabling drawings to describe Equipment Outlet configurations.

Provide detailed schedules for Video Surveillance, [Card] Access Control and Audiovisual system devices.

Terminology
Undefined phrases on the drawings such as “properly seal”, “locations to be determined”, “by others”, and “as required” shall be avoided. Provide information adequate to clearly define technical requirements and contractor responsibilities to allow for accurate bidding.

Include all details, diagrams, schedules, etc. in the drawings, not in the specifications. Often just the drawings will be at the job site.

On each floor plan sheet, show graphic scale, compass point, room names and numbers, and key plan corresponding to the architectural drawings.

For large alteration projects, separate demolition drawings are required for all areas involved in the project. Remodeling project drawings shall indicate all removal and disconnection of existing communications equipment, and shall indicate required repair of finishes.

For areas such as telecommunications equipment rooms, larger scale plans shall be used for improved clarity.

For medium and large projects, provide separate floor plans for lighting, power, fire alarm systems, telecommunication systems, A/V systems, and security systems. Combining of systems drawings is allowed if clarity of design can be maintained. The drawings shall be combined on smaller projects.

The communications drawings shall be coordinated and actively crosschecked with the drawings of all other disciplines. Consultant may be asked to provide a ¼" scale drawing of selected telecommunications equipment rooms, showing all disciplines equipment, to ensure that coordination is being achieved.

E. Specifications – General Requirements

DFD Master Communications Specifications (Division 27) are mandatory for use on all projects. Specifications should cover all major items used in the project. The consultant is required to use the latest edition available at the beginning of the design. The latest edition can be accessed on the DFD Website.

DFD Master Specifications for Communications have been developed for most electrical work. They shall be edited to meet the specific project needs. All bracketed items in the specifications shall be edited, with all brackets and non-applicable items deleted. Specifications shall be checked carefully with the drawings to be sure that everything required by the drawings is included, and that the inapplicable matter in the specifications is deleted.

The consultant shall prepare supplementary material when the DFD master specifications are not sufficient to adequately define the work. If the resultant supplementary material is not extensive, it may be inserted at appropriate locations into the master specification section; otherwise, as many new sections as necessary shall be developed in the same format as the master specifications. Confer with the DFD to confirm section numbering and proposed content.

Trade names or other indications tending to identify a product of an individual manufacturer shall not be used on any project, unless specifically approved, except as follows:

- Where necessary to identify existing equipment.
- Where an existing system is to be extended and competitive manufacturers cannot meet performance requirements.
- Where a product is identified as a Basis of Design. Regardless, specification should also identify pertinent parameters upon which equivalence is to be based.

F. Preliminary (35%) Review Stage Requirements

Preliminary Drawings

Preliminary drawings shall include the following:

- Complete set of floor plans showing all rooms with room names and numbers. North arrow(s) and keyed building location must be on all sheets and details.
- All Communication equipment rooms and major pathways are shown on floor plans.
- Backbone Cable system schematic (riser) diagrams for communications systems.
- Typical room and/or area layouts with all Equipment Outlets and other low-voltage devices. in the room. Each different room type shall have a layout. Examples of room types are classroom–small, classroom–large, auditorium, toilet, janitor closet, kitchen, each laboratory type, corridor, stairwell, patient room, cell, etc.
- Site plans showing ductbanks and manholes,. Include typical ductbank cross section detail. Include existing utilities and routing of new power and signal conduits/ductbanks. Combine w/ electrical.
- Engineering calculations and data on request. Provide data and analysis regarding any deviation from DFD standards and guidelines.

Preliminary Specifications

Preliminary Specifications should include the following:

- A complete Table of Contents.

  This shall indicate master specification sections being used on this project and to be edited by the consultant, those sections not being used (indicated by strikeout), and new sections added by the consultant.

- Marked up copy of the latest version of the master specifications.

  Markups may be by computer or by hand. Cross out unused portions. Show additions by consultant. Additions may be bold or underlined. Do not include unused sections. Do not edit out the DFD Master Specification revision date located under the section name at the beginning of each specification section.

Supplemental Submissions (for Preliminary Review Only)

Furnish fixture catalog cuts with complete highlighted model number for all types of cabling, hardware, and equipment. Indicate on cuts the general locations in which they are intended to be used such as classrooms, corridors, closets, auditoria, labs, etc., and the fixture type number.

G. Final Review Stage Requirements

Provide 100% complete construction drawings and specifications that are complete and accurate in every detail.

DFD intent is that these documents by ready to be released for bidding.

IV. STRUCTURED CABLING

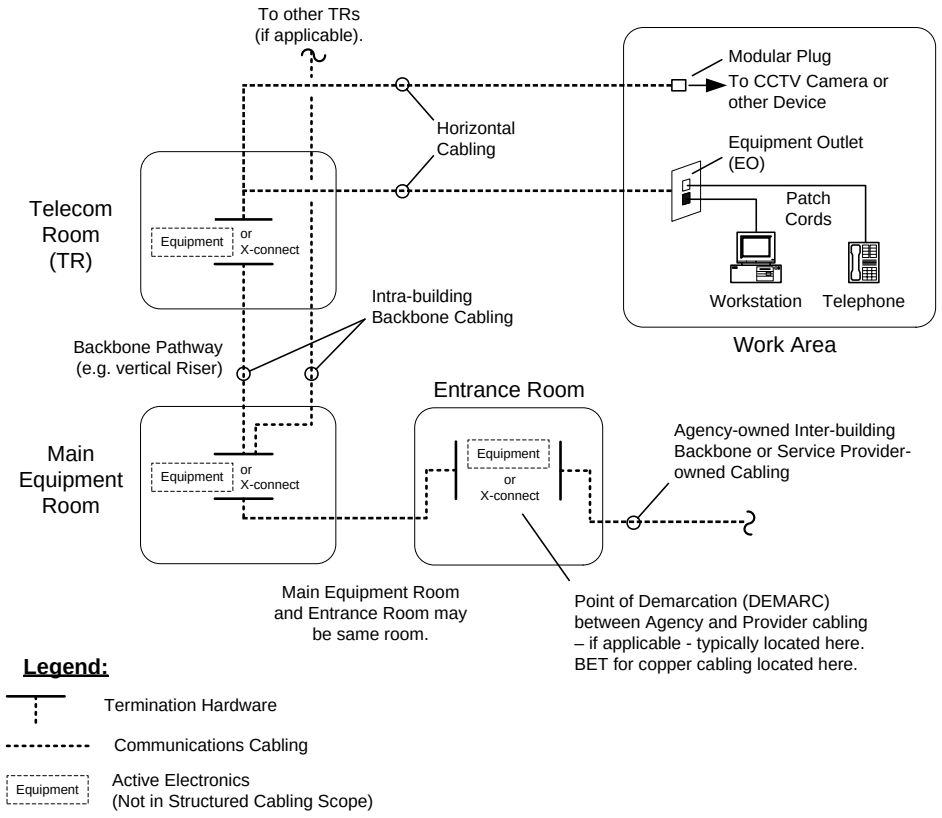
A. General

The DFD approach to building wiring for low voltage communications systems is to create a flexible and modular (structured) system capable of supporting existing technology, adapting to new technology that may be used in the future and is easily modified to support additional capacity and functionality. The system is intended to support "Voice" and "Data" applications.

"Voice" means both Telephone and legacy fax and serial data connections (e.g. 56kbps to 1.544-Mbps). "Data" usually refers to Local Area Networks (e.g. 10/100/1000 Mbps) that support part or all of a building's occupants but now might also include Security (Access Control and Video Surveillance), Streaming Media, network-based Audiovisual systems and other systems that operate at higher data rates.

The Figure below graphically outlines the scope of this document. A general description of each major area follows. The diagram is simplified and does not show all possible configurations, especially of the horizontal cabling. Refer other articles for additional detail. Note the terminology used in identifying locations, cabling and components. This terminology is used throughout this document and DFD Division 27 specifications.

Communications systems may also include wireless (RF), Free-space Optics (FSO), infrared and other technologies as required to meet the project goals. A discussion of these technologies is beyond the scope of this document.



Note:
Cross-connect (x-connect) at Main Equipment Room referred to as the Main Cross-connect". Cross-connect at Telecom Room referred to as the "Horizontal Cross-connect".

DSF Telecom Guidelines
visiodocument\scope_hierarchy
7 November 2016

Figure 1 - Structured Cabling Hierarchy

B. Cable Types

Inter-building (between buildings) and intra-building (within building) structured cabling systems are typically based on copper twisted-pair, fiber optic and coaxial cabling.

Horizontal cabling is typically copper twisted pair and coaxial cables but may include fiber optic cable on a limited basis where required to support unique applications.

Basic construction and performance requirements for each cable type are detailed in the sections below.

C. Cable Classification

Cables are classified by the National Electrical Code (NEC) as to their permitted use. In particular, the code defines environments where various cable designs may be installed including "General Purpose", "Riser" and "Plenum".

Plenum air returns are common in new construction where the area above the suspended ceiling provides the path for air being removed from the work area and returned to the air handling system. Where ducts are used as the return path (a "ducted return"), the area above the ceiling would not be considered a plenum.

The use of NEC Article 800 Type CM, CMR and CMP cabling is governed by the DFD "Communications Cabling Policy" which is available at the DFD Website. All communications cabling is to be UL listed.

- Riser cable are required where installed in vertical runs and penetrating one or more floor, or installed in vertical runs in a shaft.

- Plenum cables are required where installed in ducts, plenums, and other spaces used for environmental air. A plenum is defined by the NEC as a "compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system."
- General Purpose Cables are used where not installed in a Riser nor Plenums, and where required to be listed as being resistant to the spread of fire.

Most cables intended for outdoor use are not rated for indoor installation. A class of Indoor / Outdoor fiber optic cables are available, however, eliminating the need for conduit or to transition between cable types at a building entrance. These cables are typically higher in cost relative to unlisted outdoor cables. Engineer should evaluate all costs relating to this sub-system in developing his/her design.

A quick reference to cable classifications is attached to this document as Classification Tables Appendix which provide a quick reference to cable classifications. Designers should familiarize themselves with the Code itself, however, and reference the .

D. Inter-Building Backbone Cabling (Outside Cable Plant)

General

Identify existing campus communications hub(s) to which the project site is to be connected. Be aware that there may be multiple such locations based on application (e.g. voice, network, video, security) and/or requirement for redundant links.

Identify requirements for connectivity (cabling) between the project site and the hub location(s). For remodeling projects, identify existing connectivity and determine if it is adequate or if it is to be replaced or supplemented with new cabling.

Identify existing cable termination configuration at campus communications hub(s) and determine requirements for integrating new cabling at the hub location(s).

Identify means by which the project site is to be (or is, if a remodel project) connected to existing campus pathways (e.g. ductbank and manholes). Size building entrance to accommodate new and future cabling, and in accordance with industry and DFD guidelines.

Identify the ability of existing campus pathways – including entrance at hub building(s) – to accommodate the new cabling. Where pathways are inadequate, identify means by which required capacity is to be made available (new pathway construction, removal of abandoned cabling, etc.).

Building Entrance Terminal :

Article 800.90 of the (2005) National Electric Code requires that properly grounded Protective Devices (e.g. "Protectors") to be provided under many circumstances, the requirements being dependent on how the cable is routed (e.g. aerial or underground) and the potential for them to be exposed to current carrying conductors. The protectors are for personnel safety and for protection of telephone equipment. These Protectors must be installed close as possible to the point where the cabling enters the building, and the installation and grounding must conform to current NEC codes and customer provided equipment vendor's specifications.

Where the project includes inter-building copper cable, incoming copper cable is to be terminated on a Protector. This is typically in the form of a termination block or by splicing to a cable stub. A second cable terminated in a similar fashion exits the protector and goes to a wiring block. The connection between each pair in the incoming and outgoing cables is the Protector Module, a device that acts to shunt excessive Voltages (including transients) to ground. The combined assembly is typically referred to as a Building Entrance Terminal (BET).

Where incoming inter-building cable is by a Service Provider, identify any site/agency-specific DEMARC Configuration and develop the cable system design as applicable.

Interface should be a splice or a Termination Block of the types used on the project (typically 110-type). Use of 66 type connector blocks is not acceptable without DFD approval.

Basic Protector Module types include "Gas Tube" and "Solid State". The recommended minimum is for all copper entrances is 2-stage Gas Tube" type.

The BET and Protector Modules shall meet or be better than the requirements of UL 497 Standard for Protectors for Paired-Conductor Communications Circuits.

The BET is to be bonded to the Telecommunications Ground.

E. Intra-Building Copper Backbone Cabling

General

The Intra-building Backbone Cable" system of a building is usually a vertical arrangement that connects floors in a multi-story building. For this reason, this part of a structured cabling plan has often been referred to as the "Riser" cable. The same function can, however, be served by a lateral system to support large, single-story building. The Intra-building Backbone connects the Main Equipment Room with the Telecommunications Room(s)

Media types may include copper twisted pair, coaxial, or fiber optic cable.

Copper Twisted Pair Cable :

Copper Twisted-pair cabling intended to voice applications terminates in a collection of wiring blocks often referred to as the "Main Distribution Frame" (MDF). (Use of this term has, incorrectly, been extended to describing the equipment room itself. DFD plans and specifications should not use this term except as it relates for voice cabling.)

Pair-count of these cables should equal to 4 x the number of Equipment Outlets designated plus 30% growth for additional station locations.

- Cable will based on 24 AWG twisted pairs, with standard telephone color coding.
- Copper Backbone cable designated for telephone service meeting or exceeding performance characteristics designated for TIA Category 3.
- No splicing of backbone copper cabling is allowed.
- All backbone copper cable will be terminated and tagged at each end, with a labeling scheme provided by the State (see Labeling Section).
- Intra-building Backbone cable shall be supported by DFD approved means at intervals not to exceed four feet. Deviation from these support requirements will require DFD approval.

Copper Twisted Pair Cable Termination :

All intra-building backbone copper pairs shall terminate on 110-type Termination Blocks using 5-pair clips. Block performance shall be equal or better than specified for the cable to be terminated on them.

66-type Blocks are not allowed unless required to integrate with existing termination hardware. Engineer should confer with the DFD to confirm acceptability.

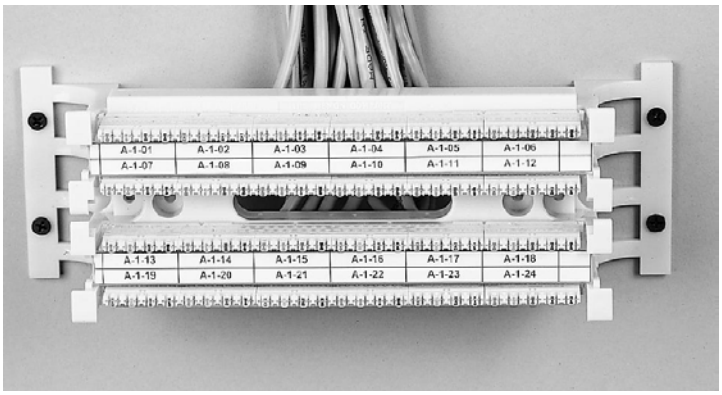


Figure 2 - 110-type Block

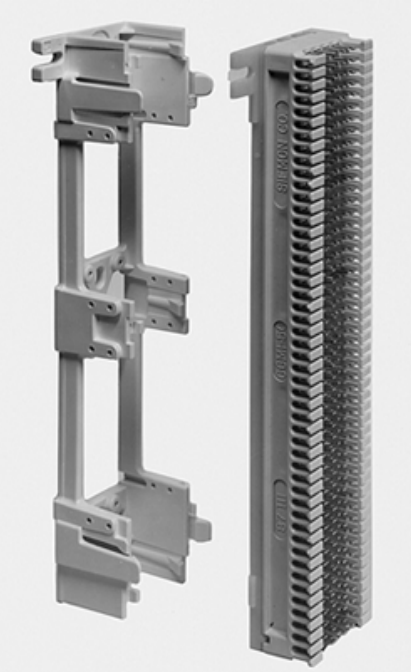


Figure 3 - 66-Type Block with 89B-type Mounting Bracket

Some projects are now using a design approach where there is no Voice/Data Distinction in Horizontal Cabling. Confer with DFD where project includes this design approach as it affects both horizontal and backbone cabling, and the connection of these subsystems.

Where an Intra-building Copper Cable includes metallic sheath elements (e.g. a corrugated shield), those elements shall be bonded to the Telecommunications Grounding system.

All pairs shall be labeled with the labeling scheme defined for the Site.

F. Backbone Fiber Optic Cable:

Fiber Optic Cable

DFD specifies Loose-buffer designs for Inter-Building Backbone Cabling (Outside Plant; OSP)". This includes Duct, Aerial and Direct-buried types.

DFD specifies Tight-buffer designs for Intra-Building Backbone Cabling (Inside Plant; (ISP).

Cables may be configured with armoring in any environment per agency preference.

Indoor/Outdoor cable may be considered where their use is determined to be cost effective. A/E should be prepared to justify the selection of this more-costly cable type during document reviews.

Optical Fiber Types

Fiber types recognized by DFD for new installations include 50/125 µm LASER-optimized multimode (OM3) and Singlemode (OS2)

Fiber counts are to be coordinated with the Agency based on site standards.

Fiber Optic Cable Termination

All fibers are to be terminated at both ends and positioned in patch panels. *Exception*: A portion of the installed fibers may remain un-terminated only upon approval by the DFD.

Recognized connector types for new installations include SC (preferred) and LC types. Agency preferences should be applied when selecting connector type(s).

Exception: Where adding on to an existing installation in which ST-type connectors are already in place, ST connectors may be used.

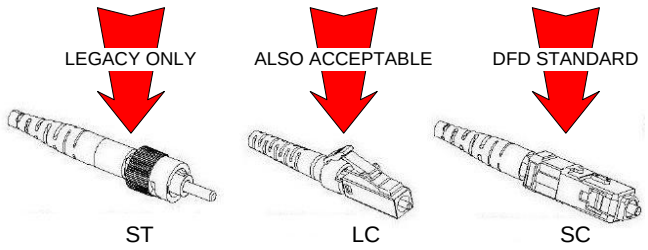


Figure 4 – Fiber Optic Connector Types

Standard polish for single-mode optical connectors is Ultra-physical contact (UPC) type.

DFD recommends consideration of using Angled-Physical Contact (APC) polish on a small portion of installed single-mode fibers. This is to support very high-speed network, wide-band CATV and DAS applications as applicable. Confer with agency and DFD Engineer to determine requirements.

Color of Connector Coupling (all except ST-type) shall indicate fiber type as follows:

- Multimode (62.5-micron) OM1 – Beige
- Multimode (50-micron; LASER-optimized) OM3 – Aqua
- Single-mode (UPC Polish) – Blue
- Single-mode (APC Polish) – Green
  APC Polish may be required on certain systems to minimize reflections. Typical applications include CATV and Distributed Antenna Systems. A/E should consider requirements for these system type and include some compliment of APC-polish connector as applicable.

Each fiber strand shall be labeled at each end as specified by the DFD (see Label section).

All terminated fibers shall be mated to Couplers which are mounted on a panel that, in turn, snaps into an enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types. Couplers for SC and LC type connectors shall be duplex.

Enclosures smaller than 2RU (vertical dimension) shall not be used.

Duplex Couplers shall be installed with polarity (e.g. keyway orientation) on each end opposite that of the other end (i.e. A-B, A-B... on one end and B-A, B-A... on the other). Polarity shall be per TIA/EIA-568-B.1, section 10.3.2. Refer to that standard for further detail.

Position optical fibers consecutively and mapped "position for position" between patch panels. There shall be no transpositions in the cabling.

The small size of the increasingly popular LC-type connector, can result in overly (and unnecessarily) dense coupler positioning. Unless mounting space is extremely limited, coupler panel selection should consider access as well as capacity.

G. Horizontal Permanent Link

General

Horizontal Cabling, sometimes referred to as “Station” cabling, extends from the Equipment Outlet (EO) in the work area to its termination at the Horizontal Cross-connect, typically in a Telecomm Room or Main Equipment Room. The connector at the EO, typically a modular jack, the cable and the termination at the HC are referred to as the “Permanent Link”.

The performance of the connector at the EO, the horizontal cable and the termination at the HC are all specified to work together to result in the desired end-to-end performance. Each component must meet minimum performance parameters for the over performance "Category" specified.

Distribution of cabling should be per agency standards and to meet the requirements for long-term connectivity at the site.

The requirement for wireless LAN (WiFi) connectivity is likely in all state buildings. Add infrastructure as applicable. DFD recommends:

- Providing horizontal cabling to support agency-provided Wireless Access Points (WAP) on 60-foot square grid unless directed otherwise by Agency staff.
- Designing to support WAP density in compliance with TIA-4966 Telecommunications Infrastructure Standard for Educational Facilities unless directed otherwise by Agency IT staff.
- Including (2) 4-pair cables, performing to Category 6 limits to each potential WAP location location.
- Consideration of cable performing to Category 6A limits per TIA TSB-162-A– Telecommunications Cabling Guidelines for Wireless Access Points. If Category 6A is selected, suggest F/UTP cable type.

Performance

DFD standard for horizontal cabling calls for performance which exceeds the requirements of TIA/EIA Category 6 criteria. Minimally complaint Category 6 cabling and termination hardware is not acceptable for installation on State of Wisconsin DFD projects.

Compliance shall be determined as follows:

Manufacturer's published literature shall document performance margins over worst-case ANSI/TIA-568-C.2 Category 6 Channel requirements for Power Sum Attenuation-to-Crosstalk Ratio (PSACR).

Margins shall be documented at all frequencies up to and including 250-MHz. (PSACR shall remain positive above the 250-MHz limit considered by the TIA standards.)

Channel, as tested, shall include 4-connections (minimum).

Data shall be verified by an independent source (e.g. ETL. Intertek).

DFD recommends considering links performing to Category 6A limits be used at locations intended for Wireless Access Point as per TIA TSB-162-A–Telecommunications Cabling Guidelines for Wireless Access Points. Confer with agency contacts and DFD engineer to confirm requirements. Higher-performing links are especially recommended in academic and health care applications or where high user-densities are anticipated.

If Category 6A is selected, suggest F/UTP cable type. Confer with DFD engineer to confirm specification language.Horizontal cable systems limited to meeting TIA Category 5e are unusual and should be considered only where adding to an existing cable system or where requirements for higher-performance are unlikely. Category 5e content is removed from this section. Confer with DFD Engineer to confirm instances where Category 5e performance may be appropriate.

Cable and connecting components that comprise the "Permanent Link" shall meet or exceed the requirements for "DTE Power via the MDI" to provide at least 25 W at the Powered Device as defined by the IEEE 802.3at-2009 "Power over Ethernet Plus (PoE+)" standard.

Application

Traditionally, there has been a distinction between cabling designated for "Voice" and "Data" applications. With the advent of network-based voice communications systems (e.g. Voice-over-IP; VoIP), this distinction is less common.

Where there is no distinction between cables designated for "Voice" and "Data" applications with all cables are considered as for "Data" and terminated on Modular Patch Panels at the horizontal cross-connect. This approach is acceptable to the DFD. A/E should take care in understanding the "Voice" circuit, in particular, the connection between the horizontal and backbone cabling.

Where Voice-over-IP (VoIP) implementation is part of the design concept, attention should be paid to the number of cables to each Equipment Outlet. VoIP system offer the option to "share" (1) horizontal cable with multiple services.

Also allowable on DFD projects are "Zone Cabling" installations whereby horizontal cabling is extended to an interconnect location in the work area. This interconnect or "Consolidation Point (CP) has advantages where frequent reconfiguration is probable (e.g. in open office areas featuring moveable systems furniture, lab areas and in flexible classroom space such as Active Learning Classrooms (ALC). A solid-conductor cable extends from the CP to the Equipment Outlet at the user location.

DFD recognizes the following cable counts for various environments and applications:

- For a standard, fixed-wall office: (2) 4-pair links designated for "Data".
  Where there is a Voice/Data distinction, a link designated for "Voice" can also be included.
  In larger offices, (2) EOs so equipped should be positioned on opposite walls allowing for reconfiguration of furniture.
- For a workstation/cubicle: (1) 4-pair links designated for "Data".
  Where there is a Voice/Data distinction, a link designated for "Voice" can also be included.
  Additional links for "data" may be provided in a grouping of cubicles to accommodate shared devices (e.g. printer).
- Coaxial and, in special applications, fiber optic connectors may be combined with the modular jacks in an Equipment Outlet.
- For locations designated for Wireless Access Points: (2) 4-pair links designated for "Data".
- For locations designated for a Video Surveillance Camera or other security device: (1) 4-pair link designated for "Data".

Horizontal Cable

Un-shielded Twisted-Pair(UTP) performing to TIA Category 6 limits as noted above is the default choice for the horizontal cable on DFD projects unless noted otherwise.

Use of shielded cabling may apply on cabling to location for certain Video Surveillance camera types and for Wireless Access Points, especially where Category 6A performance is specified.

Where a shielded cable is called for, the cable shall incorporate an overall foil shield under the cable jacket and no shielding around individual pairs.

This cable is referred to herein as "F/UTP - Foiled Unshielded Twisted Pair". "ScTP - Screened Twisted-pair" is also sometimes used in industry publications to describe the cable type.

Termination at Horizontal Cross-connect

Horizontal cabling designated for "Voice" applications shall terminate at the Horizontal Cross-connect on Termination Blocks (e.g. 110-type or similar IDC design). These blocks are typically wall-mounted.

Horizontal cabling designated for "Data" applications shall terminate at the Horizontal Cross-connect on Modular Patch Panels. Where there is no Voice/Data Distinction in Horizontal Cabling, all horizontal cabling shall be terminated in this fashion. These Patch Panels are typically rack-mounted.

All Cabling and Termination Hardware shall be labeled with the labeling scheme provided by the State. See section 27 05 53 for labeling standards.

Equipment Outlet

Equipment Outlets in office environments shall be configured per Agency standards for the site.

The EO faceplate shall be a one-gang design. (Backbox shall be 4-11/16" square x 2-1/8" deep ringed to a single-gang opening). Exceptions to this configuration may be considered for special applications with DFD approval. A typical faceplate configuration in an applicate with a "Voice/Data" distinction would be as follows:

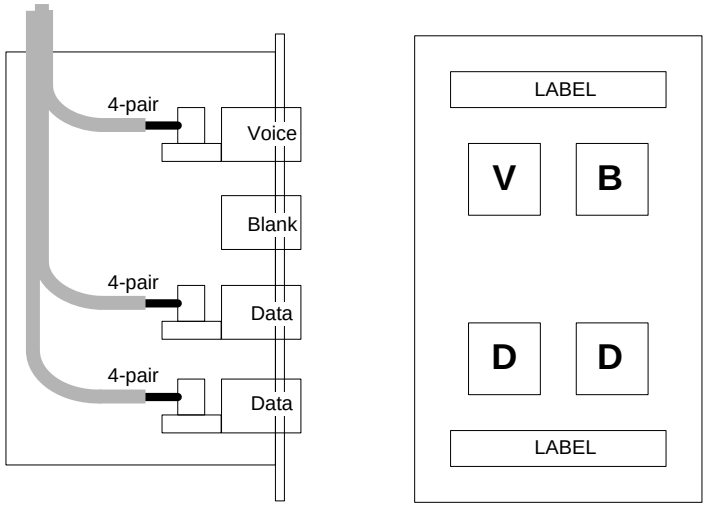


Figure 5 – Equipment Outlet (typical)

Outlet configurations must be uniform throughout the system except where specifically noted or approved by the DFD. Connectivity at a particular Equipment Outlet (EO) location is dependent on the location type.

Any unused connector position is to be fitted with a blank, color-matched to the faceplate.

Equipment Outlets which support a unique/special application include:

- Wall-mounted Telephone Jacks
  Wall-mounted EOs installed to accommodate wall-mounted telephone sets shall be single-gang, Stainless Steel, accommodate one (1) Modular Jack of the type designated for "Voice" applications (or universal if no such distinction) as defined herein, and include mating lugs for wall phone mounting.
- Common areas (e.g. for printers, copier, legacy FAX, shared computers, other)
- Mechanical and Electrical Rooms
  Coordinate w/ electrical and mechanical designers to confirm requirements for communications into these and similar rooms. Applications might include provision for wall-mounted telephone sets or a communications interface for monitoring/control equipment (especially for mechanical equipment).
- Elevator Control Rooms
  Coordinate w/ elevator system design to ensure a communications interface for cab telephones and, if applicable, security devices (e.g. Card Access, Video Surveillance).
- Audiovisual Equipment Locations, including Video Displays.
- Wireless Access Point (WAP)
- Video Surveillance Cameras (Network-type)

<u>Modular Jack</u>
At the user or device location, horizontal copper twisted-pair cabling shall be terminated 8-pin, 8-conductor (8P8C) Modular Jacks. This jack type is often referred to as an "RJ-45".

The cable interface shall be an Insulation-displacement (IDC) type. This may be 110-type or proprietary as required to meet performance objectives.

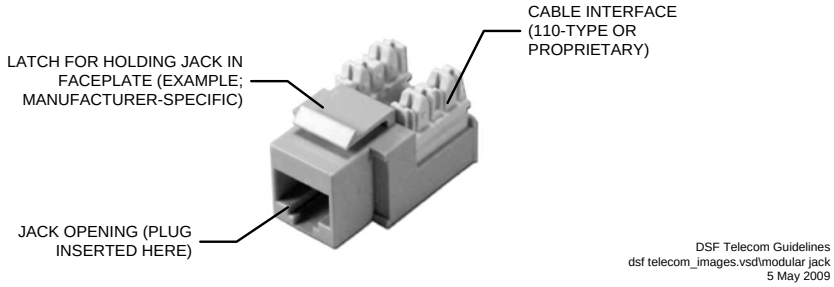


Figure 6 - Modular Jack (typical)

The DFD recognizes both the TIA/EIA T568A and T568B pin-pair assignments for these connectors. Selection of the standard to be followed is per standards developed by the Agency responsible for the site.

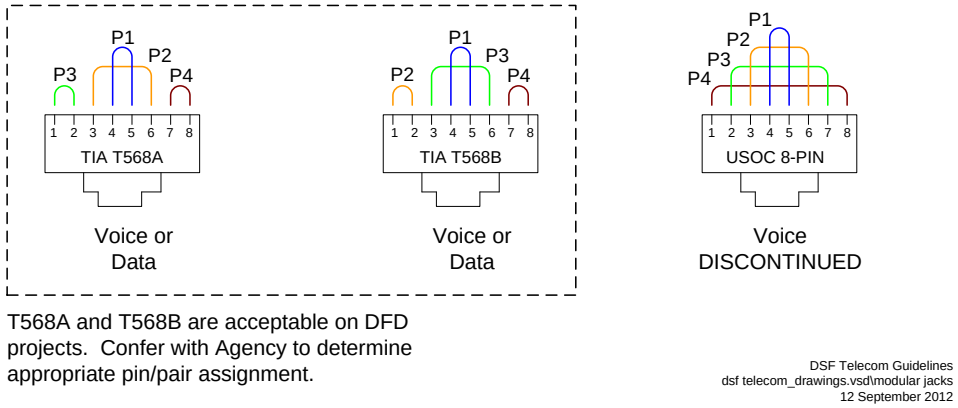


Figure 7 - Jack Pin-Pair Assignment Formats

Where multiple agencies occupy a building or site, the DFD in cooperation with the Division of Facilities Management (DFM) will define the pinning conventions to be used.

H. Modular Plug for Access Point and Security Cabling

Some agencies prefer to terminate horizontal cabling at locations designated for Wireless Access Points and security Devices (e.g. camera or card access controller) in a Modular Plug rather than a jack. This is acceptable on DFD projects.

The Plug should be designed for field-installation and meet the performance criteria of the link.

Provisions of ANSI/TIA-862-B – Structured Cabling Infrastructure Standard for Intelligent Building Systems apply to such cabling.

I. Cross-Connect Jumpers and Patch Cords:

Providing Patch Cords on DFD Projects for new and remodeled buildings is acceptable. Quantities should be limited, however. Refer to the listing below for acceptable quantities of each cord type.

Acceptable quantities are as follows:

- Actual number of 4-pair Modular patch cords for “Voice” and “Data” as required for 1st Year occupancy of a new or re-modeled building. This would include patch cords at both the work-station and at the “Horizontal Cross-connect” / Wiring Hub (e.g. Telecom Room; TR). If the Agency wishes to connect more jacks, that would be their cost.

- Actual number of 4-pair UTP Modular-to-110 patch cords as required to complete horizontal-to-backbone cross-connect as applicable for the project.
- Fiber optic patch cords as required to connect the building to the campus/institution network. For a redundant connection, this would typically be (2) duplex patch cords at the project building and (2) at the "other end". Additional patch cords may be added to support CATV distribution where applicable.
- Fiber optic patch cords as required to connect the main [Telecom] Equipment Room with each of the Telecom Rooms (TR). This is to provide connectivity for the new networks. Assuming a redundant connections, this would equate to (4) duplex patch cords per Telecom Room – (2) at TR and (2) at the Main Cross-connect (Main Equipment Room). Additional patch cords may be added to support CATV distribution where applicable.

Quantities greater than indicated must be approved by the DFD.

J. Wide-band Video Distribution System

General

A Wide-band Video Distribution System includes cabling and termination components, and passive and active distribution hardware.

The extent of such a system for DFD projects depends on Agency preference and how video services are to be provided.

At minimum, cabling for video distribution should be included in a project where such services are anticipated.

Cabling and Termination Hardware

Backbone cabling may include:

- 0.500" coax
- RG-11 Coax

RG-11 Coax is typically the preferred cable type unless 0.500" type is require due to distance or other factors (e.g. powering of repeaters) which are unusual for DFD projects.

Horizontal Cabling shall be RG-6 type Quad Shield. RG-11 may be considered where the cable lengths require lower loss to meet design goals. RG-59 may be used on smaller installations with DFD approval.

Acceptable topologies include:

- "Home Run" design whereby all horizontal cabling extends from the coax outlets at the device to the Horizontal Cross-connect (e.g.). This approach is generally preferred by DFD.
- "Trunk-and-Tap" design whereby a backbone cable (or multiple cables) is extended from the Horizontal Cross-connect through the area where coax outlets are located. Passive Taps are positioned along this backbone cable. Cabling is then extended from the Tap to the Coax Outlet.

The A/E should confirm any Agency topology preference (if applicable). Where no preference is identified, consider the overall CATV design when specifying the cabling.

Distribution Components & System Performance

Where a comprehensive distribution system including passive and active components is required, it shall be the responsibility of the A/E to develop a preliminary design identifying topology and the required components. During construction, it is then the responsibility of the contractor to refine the design and identify Splitter/Tap performance and amplification requirements in order to achieve the desired signal level at the Coax Outlet.

A/E should confirm (1) system video bandwidth and (2) if bi-directional system design (e.g. for (interactive / two-way services) is required. Bi-directional system are unusual for DFD projects.

The system should be designed to provide for a signal level of 0 – 10 dBmV, as measured at the TV Outlet over the applicable frequency range.

- Low frequency limit of 55 MHz is typical. Typical upper frequency limits are 550, 750, 860 and 1000 MHz. The frequency range is site-specific and must be confirmed with the Agency.

All Passive Distribution hardware shall be designed to support a video bandwidth of 1 GHz.

Active Hardware (e.g. Amplifier; if applicable) shall support a video bandwidth as required.

The designer must coordinate with the Agency to confirm the signal level to be assumed at the building entrance.

K. Transmission System Conversion
Future Section.

L. Contractor Qualifications
Future Section

M. Warranties
The default requirement for warranty on the Horizontal Copper Permanent Link is an extended warranty of 15 years. Warranty is to be direct from the manufacturer(s) of cabling and connecting components.

Exception: Where cabling is terminated in a modular plug not covered by an extended warranty or where existing connectivity is used (e.g. spare ports in existing modular patch panel), such links shall be covered by a 2-year system warrant. In the latter case, the contractor is responsible for only those items provided.

Copper Backbone – 2 years.

Fiber Optic Backbone – 2 years.

V. EQUIPMENT ROOMS AND OTHER SPACES

A. Room Types and Hierarchy

A/E responsible for coordinating with Architect to ensure space, room size, pathways, etc. as required are included in the project.

A/E is responsible for coordinating with other design team members to ensure electrical power and lighting, mechanical and security provisioning for the room is as recommended. Coordinate with other low-voltage systems designers to ensure proper allocation of equipment mounting space (wall and rack).

The DFD has adopted the recommendations TIA-569-C "Commercial Building Standard for Telecommunications Pathways and Spaces" in its guidelines relating to equipment room hierarchy, room size and fit-out, and pathways linking the rooms. The guidelines can be modified with DFD approval but should be considered as the "starting point" on all projects.

For purposes of this guideline, the following terms will be used to indicate room classifications.

- Entrance Room (ER) – The location where –inter-building backbone cabling (Agency- or Service Provider owned) enters the building and is initially terminated. Lightning protection on copper cabling is typically located here. It may be a separate room or, as is often the case, combined with the Main Equipment Room.
- Main Equipment Room (MER) - The heart of a building's communication system, this is the point of termination of all inter- and intra-building backbone cables. These termination are referred to as the "Main Cross-connect". (These cabling connections as they relate to copper cabling are sometimes referred to as the "Main Distribution Frame (MDF), an outdated term relating to telephone cable distribution.) Network, Voice, Security and other electronics which serve the building as a whole are typically located here.
- Telecommunications Room (TR) - Where Horizontal Cable from the surrounding work area is terminated. These termination are referred to as the "Horizontal Cross-connect". Backbone Cable links each TR to the Main Equipment Room (These cabling connections as they relate to copper cabling are sometimes referred to as the "Intermediate Distribution Frame (IDF), an outdated term relating to telephone cable distribution.) Network, Voice, Security and other electronics which serve the work area are typically located here.

  Replace references to "IDF" with "Telecommunications Room" to conform to DFD and industry standard terminology – unless this is an Agency preference. "IDF", although commonly used, is an obsolete and incorrect term for referring to an equipment room.
- Telecom Enclosure (TE) – An enclosed cabinet which houses cable termination and electronics intended to serve a small area. This is used where cable counts do not merit construction of a room but where cabling distances or other factors require

Every building shall contain at least one equipment room for Telecommunications. There is no upper limit on the number of Telecommunications Rooms which may be provided within a building.

There may be a number of TR's in a building depending on the size and outline of the building, function and occupancy. The location of the TR is to be planned so that no horizontal cabling exceeds 295 feet in length. (For design purposes, 250-feet – as measured along likely cable paths and at right angles (not straight-line) - should be used in identifying the need for a TR.) Where a single TR per floor is adequate, it is best located in the center of the floor. (Note that in a small building, the TR and Main Equipment Room are typical the same room.)

For new construction or major renovations, where multiple equipment rooms are required, they shall be aligned vertically.

Telecommunications cabling and equipment shall be located in dedicated room(s) and not share space with mechanical equipment, electrical panels or other distribution equipment unless this equipment is related to the telecommunications function.

No piping or ductwork will pass over or through a Telecommunications Equipment Room unless used to provide services to the room itself. Coordinate piping and ductwork used to provide services to these rooms with the anticipated equipment layout within the rooms.

Layout, design and provisioning of equipment rooms for communications must be approved by the DFD before installation.

B. Equipment Room Provisioning

General

False ceilings shall not be allowed.

The access door shall be a minimum of 36 inches wide and 80 inches high and shall be fitted with a lock. A larger double-door may be merited for the Main Equipment Room in larger installations to facilitate movement of equipment into and out-of the room.

Floors, walls, and ceiling shall be treated to eliminate dust and static electricity. Finishes shall be light in color to enhance room lighting.

Layouts shall be verified with equipment providers for weight and distance limitations between cabinets. Doors providing access to other areas of the building through the equipment room should be avoided to limit access to the equipment room to authorized personnel only.

Minimum clear height in the room shall be 8 feet without obstructions.

A minimum of two walls should be covered with rigidly fixed 5/8 inch trade size A-C plywood, preferably void free, 8 feet high, capable of supporting attached equipment. Plywood shall either (1) be flame-retardant type or (2) painted with a flame-retardant paint. If possible, locate the space for terminations on one continuous wall to avoid lost space for corners.

The painting of fire-retardant/treated plywood using fire retardant paint is not a requirement of DFD nor of applicable standards and is not recommended.

Where painted, masking of the fire-rating stamp on the plywood is recommended to ensure it remains visible.

Lighting

Provide fixtures to illuminate the areas in front of and behind the row of equipment racks.

Illumination shall be a minimum of 50 foot-candles measured 3 ft. above the finished floor, in the middle of all aisles between cabinets and racks. Fixtures should be mounted at least 8.5 feet above a finished floor and located so illumination is not obstructed by equipment, racks or cabinets.

The lighting shall be controlled by switch located near the entrance door(s) to the room. Occupancy sensors or timers shall not be used in this room type.

Fixtures shall be fluorescent-type with acrylic diffuser similar to Lithonia AW-series (surface mount).

Fixture placement and support should not impede cable pathways.

Power

At the Main [Telecommunications] Equipment Room (MER) serving a building, electrical power requirements for the room are dependent upon the equipment load and should be coordinated with

the Agency. At minimum, the room shall be equipped with a minimum of two dedicated 20 ampere, 120V duplex receptacles for equipment power. For large applications, a separate electrical panel which serves the room may be appropriate.

A typical Telecommunication Room (TR) shall be equipped with a minimum of two dedicated 20 ampere, 120V duplex receptacles for equipment power.

Main [Telecommunications] Equipment Room and Telecommunications Room(s) shall be equipped with 20 ampere, 120V duplex receptacles spaced at 6 ft. intervals around the perimeter walls, at a height of 18 in. above the floor / matching the rest of the building. A minimum of two such receptacles shall be provided. Receptacles for convenience and miscellaneous use may be on shared circuits.

Additional circuits may be required depending on equipment populating the room. Examples include circuits required for security equipment, fire alarm and other system.

208V service should also be considered as many larger UPS's require this. A/E should coordinate requirements with the Agency and DFD.

If a standby power source is available in the building, the panels serving Telecommunications Equipment Rooms should be connected to the standby supply.

Configuration and number of receptacles for equipment power shall be coordinated with the Agency. In larger installations, placement of receptacles on equipment racks rather than on-the wall should be considered to keep cord lengths short.

Mechanical
Some means of ventilation should be provided for all equipment rooms for communications.

This air should be filtered and the temperature continuously maintained between 65- and 80-degrees F. The relative humidity of the room should not be more than 55% and not less than 30%.

- At minimum, the mechanical design should allow for at least one air exchange per hour.
- Supplemental cooling should be provided if the heat loads are expected to be high enough as to no allow for the indicated temperature range to be met with simple ventilation.

Any supplemental cooling system should be designed to operate independently of systems which serve the surrounding area and be designed to operate 24/7/365.

Mechanical system equipment and piping should be located outside the Telecommunications [Equipment] Room. If this criteria cannot be met, A/E should discuss options with the DFD Engineer to identify alternate approaches.

Fire Protection
Fire protection of the equipment room for communications, if required, shall be provided according to applicable code.

Sprinkler heads, as required, shall be provided with wire cages to prevent accidental operation.

Room Security:
The room will be a single-purpose room, and will not serve as an access to any other room or storage closet.

Miscellaneous / Other
The room should be free of corrosive, explosive or combustible gases.

Equipment rooms should not be used as store rooms.

C. Room-specific Requirements

General
Refer to TIA-569-C "Commercial Building Standard for Telecommunications Pathways and Spaces" for default room size.

DFD policy on this is evolving. Confer with DFD to confirm latest guideline and acceptable deviations from the Standard.

Entrance Room :
The room or space shall be located in a dry area not subject to flooding and as close as practical to the Entrance Point.

Size room based on requirements to accommodate Agency and Service Provider cabling and equipment.

Main Equipment Room
The room shall be located in an area that is not restricted by building components that limit expansion such as elevators, or fixed walls.

Accessibility for equipment delivery should be considered.

Select a dry area not subject to flooding and as close as practicable to the vertical backbone pathway. The room shall not be located below water level unless preventive measures against water infiltration are employed. If the equipment room is located under a parking area, washroom or toilet, a water proof ceiling is required.

The room shall be free of water or drain pipes not directly required in support of the equipment within the room. A floor drain shall be provided within the room if water ingress exists.

The equipment room should have ready access to the main HVAC delivery system.

The room should be located away from sources of electromagnetic interference.

Loading capacity in the room shall be sufficient to bear both the distributed and concentrated load of the installed equipment. The distributed loading shall be greater than 250 lbs/sqft. and the concentrated loading shall be greater than 1,000 lbs. over the area of greatest stress.

When designing the equipment room floor space, allowance shall be made for non-uniform occupancy throughout the building. The practice is to provide 0.07 m2 (0.75 ft2) of equipment room space for every 10 m2 (100 ft2) of work area space. The equipment room shall be designed to a minimum of 14 m2 (150 ft2).

Telecommunication Room (TR):
The Telecommunications Room (TR) on each floor is a transition point between the Backbone Cable System and the Horizontal Distribution System. A Telecommunication Room is an area within a building for the exclusive purpose of housing equipment associated with the telecommunications wiring system.

There shall be a minimum of one telecommunication room per floor. Additional rooms should be provided when:

- The floor area to be served exceeds 10,000 square feet.
- The horizontal distribution distance to the work station exceeds 295 feet.

On the basis of one work station per 100 Square Feet, the telecommunications room should be sized as follows:

Area Served (sqft)	Room Dimensions (minimum in feet)
≤ 5,000	10 x 7
≤ 8,000	10 x 9
10,000	10 x 11

Additional space should be provided where the room serves additional systems, especially Audiovisual.

Buildings smaller than 1,000 square feet may consider and use wall-mounted or free-standing cabinets.

The above requirement may be modified for special use facilities such as sports arenas, warehouses, auditoriums, etc., at the direction of the Division of Facilities Development.

Multiple rooms on a floor shall be interconnected by a minimum of **[one][two]** 4" conduit or by a cable tray of equivalent capacity.

Telecommunications rooms shall be located on floor areas designed with a minimum floor loading of 50 lbs. per sq. feet. Concentrations of equipment that exceed the minimum floor loading shall be verified.

Telecommunications Enclosure
Future Section.

VI. CABLE PATHWAYS

A. Inter-building Backbone Pathways

Site Work

Communications consultant shall coordinate the excavation work required for Division 27 with Division 26 designer, site plan and other architectural work. All excavation and backfill work to accomplish electrical systems installation shall be performed in accordance with DFD Division 31 – Earthwork. Make sure this specification section, or its requirements, are included in the project specifications.

Consultant shall identify known underground utilities on the project drawings for areas where excavation for communications installations will be taking place. Consultant shall be aware of major underground utilities such as steam tunnels, which will affect underground installations, and design accordingly.

For projects at existing facilities, consultant shall coordinate with DFD and the agency to have agency-owned utilities located. The agency is responsible for locating utilities that they own.

Utility Coordination

The consultant shall coordinate service entrance arrangements with the serving utility and shall note the utility requirements on the project drawings.

Documents shall specify if utility costs are to be included in the bid or if they are covered under separate contract. The State prefers to pay for utility extensions under separate contract with the utility. The consultant shall coordinate extension with utility, obtain extension cost from utility, and notify the DFD project manager of cost.

Consultant shall coordinate with Division 1 and utility or agency staff for requirements of temporary construction power. If provided by utility, identify responsible costs and voltage/amp requirements. If provided from existing facility or campus, identify source and voltage/amp requirements along with source location.

Consultant shall take into account any utility or municipal easements on State property and State easements on municipal property. Consultant shall confer with utility or municipality to determine the conditions for new and/or existing utility routing and/or rerouting on municipal property. Confer with agency when new easements are requested on State property.

Building Entrance Facility

The Entrance Facility provides a means for the Local Exchange Carrier (LEC) or other access/service provider(s) to route cabling into the building. The location at which telecommunications facilities enter a building is often determined by the path of the outside cable plant, the architectural plan, landscaping/elevation and other factors.

The Entrance Facility consists of the path these facilities follow on private property, the entrance through the building wall or floor, and the pathway continuing to the Entrance Room The entrance is usually an underground path through the building wall but may also follow an aerial path.

The Entrance Room - sometimes an area allocated for this purpose in a shared room (a Mechanical Room, for example) - should be located as close as possible to the location of the building entrance. Per the 2011 NEC Article 800 “Communications Circuits”, the “Point of Entrance” within a building is defined as follows:

> “[T]he point at which the wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit or an intermediate metal conduit grounded to an electrode in accordance with [NEC Cable and Protector Grounding Article] 800.100(B)”.

If the room is further than 50-feet from the point of entrance, cabling must be in conduit or a cable rated for indoor installation used. The latter approach requires the use of an indoor/outdoor type cable or a transition between cable types. Cables used in underground and aerial installations are typically not rated for indoor installation.

Entrance Conduit

An Entrance Point is a component of the service entrance facility, and is the point of entry into the building. This may be a penetration of the foundation wall, through the floor or penetration of an exterior wall above grade. Conduit entering from below the level of the finished floor shall extend 4 inches above the finished floor. If the conduit enters above a suspended ceiling, it will terminate 4 inches below that finished ceiling.

Where penetrating the building foundation, conduit shall extend into undisturbed earth (beyond the backfill area next to the wall) and at least 5 feet beyond the foundation's exterior. When terminated at the inside of the building wall, the conduit shall have a smooth bell-shaped finish unless it extends to the entrance room or space. The conduit or sleeve shall be securely fastened to the building and grounded by use of a grounding bushing.

Underground conduit should be installed such that a slope exists at all points to allow drainage and prevent the accumulation of water. The conduit should slope downwards away from the structure. Where water infiltration is anticipated, an exterior drainage box shall be installed at the Entrance Point. A "Drain Slope" of not less than 0.125 (1/8) inches per foot is desirable.

Placement of a Handhole/Manhole at the building entrance should also be considered if needed to facilitate cable installation.

Conduit should be provided into the building based on type, size, and quantity of cables that will be required to provide telephone service. The LEC and other access/service providers can advise on how they anticipate that the building will be served and their conduit requirements..

The following schedule will be used in determining the overall entrance conduit capacity

Building Size	Qty. & Size Conduits
Small	Two 4-inch conduits
Medium	Four 4-inch conduits
Large	Six to Eight 4-inch conduits

All entrance conduit will be continuous, and will be installed from the designated property line to the Entrance Room.

Refer to DFD Electrical Guidelines and Division 26 sections for allowable conduits types for various environments encountered on DFD projects.

In addition, multiple 2-inch conduits should be considered to accommodate other needs including video, tie cables, fire alarm cables, control cables, CCTV cables, miscellaneous circuits or dual feeds.

Where the Entrance Room is not located at a building exterior wall, the capacity of the pathway between the Entrance Point and the Entrance Room or space, shall match that of the entrance pathway unless the route is through open accessible areas. In such cases, the pathway placed may be only for those cables initially installed with supporting structure adequate to accommodate future pathway requirements.

Spare capacity for future growth must be provided and this spare capacity includes "planned" areas where, currently, no buildings or small concentrations of owned buildings presently exist.

All conduit shall be plugged to restrict infiltration of gas, water, and vermin. An external venting system may need to be installed to ensure that gases do not enter the building.

- Consider the following requirements when planning conduit facilities:See DFD Master Specifications - Divisions 26 and 27, and coordinate.
- Outside plant conduits for communications should be no longer than 250-300 feet without terminating at a building, signal manhole, pull box, or hand hole. This length should be less than 250 feet if the conduits have bends totaling up to 180-degrees.
- Bends in underground conduit and duct are undesirable, however, when required up to two 90 degree bends are permitted between pull-boxes or other such points where cabling can be accessed. Note that this differs from electrical ductbank design where three (3) ninety (90) degree bends are permitted.

  Bends shall have a radius not less than six times the internal diameter of conduits 2 inches or smaller, or ten times the internal diameter of conduits larger than 2 inches. (See Figure below)

  Bends shall be made using steel conduit or duct and shall be concrete encased when part of an underground ductbank.

- All single four (4) inch conduit lengths must have true circular cross sections providing a clear even raceway.
- RGS shall be used at manhole and building entrances, and at all bends. Transition between conduit types shall be made with steel to PVC or steel to polypropylene adapters.
- In making joints, the ends and couplings must be coated with joint adhesive or sealing compound approved by the duct manufacturer and driven into a tight fit. All excess compound must be removed.
- Conduit ending in manholes, building entrances, etc., must be terminated with waterproof bell ends or conduit terminators.
- All conduit duct banks must be of uniform construction. Where a connection is made to a manhole or building, the concrete encasement must be well bonded or doweled to the structure and a waterproof seal provided.
- Duct spacers or duct tiers must be installed at manufacturer-recommended intervals to support and secure the conduits of the duct banks while pouring of concrete.
- Conduit entering a building or manhole must be grounded per DFD Master Specifications. Refer to Division 26 Grounding and Bonding sections.

B. Direct-buried Cable

Future Section.

C. Intra-building Pathways - Pull and Junction Boxes

Size Pull Boxes for communications, security and other low-voltage applications per TIA-569-B "Commercial Building Standard for Telecommunications Pathways and Spaces" as follows unless noted otherwise on drawings.

Location/Spacing

Pull boxes shall be positioned on straight sections of conduit.

Locate pull boxes for communications, security and other low-voltage applications per TIA-569-C "Commercial Building Standard for Telecommunications Pathways and Spaces". Provide pull and junction boxes for telecommunications and other low-voltage applications as follows:

- In any section of conduit longer than 100 feet.
- Where there are bends totaling more than 180-degrees between pull points or pull boxes.
- Wherever there is a reverse bend in run.

Size

Where used with raceway(s) smaller than 1¼" trade size, minimum junction box size shall be 4 11/16" square by 2-1/8" deep.

Where used with raceway(s) of 1¼" trade size or larger, pull box shall:

- For straight pull through, have a length of at least 8-times trade-size diameter of largest raceway;
- For angle and U pulls:

  Have a distance between each raceway entry inside box and opposite wall of box of at least 6-times trade-size diameter of largest raceway, this distance being increased by sum of trade-size diameters of other raceways on same wall of box; and

  Have a distance between nearest edges of each raceway entry enclosing same conductor of at least six times trade-size diameter of raceway; or six times trade-size diameter of larger raceway if they are of different sizes.
- For a raceway entering wall of a pull box opposite to a removable cover, have a distance from wall to cover of not less than trade-size diameter of largest raceway plus 6-times diameter of largest conductor.

D. Intra-Building Pathways

Vertical Pathways:

Vertical Pathways provide the means for routing of backbone cabling between floors

Vertical pathways may be in the form of:

- Sleeves
- Slots
- Conduit

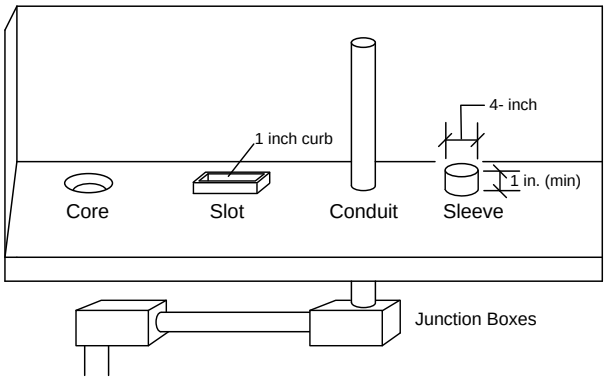


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Figure 8 – Vertical Pathways

Sleeves or slots shall not be left open except during cable installation and shall be properly fire stopped upon completion of the construction project.

Pathway requirements are to be specified in Division 26 sections.

Open shafts or cores are not frequently used except where great quantities of cabling is required on a floor that is distant from the Main Equipment Room.

Sleeves and Slots:

Sleeves are short segments of metal tubing positioned in an opening between floors.

Slots are, as their name implies, narrow, rectangular openings in the floor.

These approaches are used for installation in TR rooms that are vertically aligned. Sleeves or slots should be adjacent to the wall that will support the riser cables.

The following guidelines apply:

- Metal sleeves that penetrate a hallway wall or a wall between rooms does not have to be grounded.
- Sleeves should extend 1 inch above the floor level. Slots should be surrounded by 1 inch high curb. This is to prevent liquids from flowing through the opening (e.g. where a floor is being cleaned or there is a spill, for example.
- Where Sleeves are used as the vertical pathway, provide:

  (2) four inch sleeves per room for up to 50,000 square feet of office space plus(1) spare sleeve, and

  (1) additional sleeve for each additional 100,000 square feet of office space..

- Where Slots are used as the vertical pathway, provide:

  (1) 6” x 9” Slot. for up to 250,000 square feet of usable office area.

  (1) 6” x 18” slot for 250,000 to 600,000 square feet of usable office area.

Conduit:
Metallic raceways or conduits shall be used:

- To run cables point to point when intermediate splices or terminations are not required.
- As protection for fiber optic cable where a high degree of security is required.
- As a vertical path for backbone cabling when it is not possible to vertically align the TR rooms.

The applicable guidelines for conduit include:

- Guidelines identified for building entrance conduit.
- Conduits not being used must capped at both ends. IMC and RMC must be threaded.
- Changes in direction should be made by bending the conduit or, if required by installation conditions, at a pull box. A Conduit Body (used to provide access to wires placed within a conduit) shall not be used.
- The inside radius of a conduit bend shall be not less than 10 times the normal diameter of the conduit and not less than 24 inches.
- Total bends between pull boxes shall not exceed 180 degrees (e.g. two 90 degree bends, four 45-degree bends, etc.).

Riser conduits must be grounded. See section 26 05 26.

E. Horizontal Pathways

General
Horizontal pathways are facilities for the installation of telecommunications cable from the Telecommunications Room (TR) to the work area's Equipment Outlet locations. A system of horizontal pathways shall be installed on each floor and shall provide a cable route from each TR to all workstations on a floor or to consolidation points

The cavities above a suspended ceiling are usually used as a pathway for telecommunication cables in the State of Wisconsin buildings. The design shall provide a suitable method for supporting cables and wires from the TR to the workstation to be served. Utility columns, walls, etc., provide pathways for the wires and cables from the ceiling to the Equipment Outlet location.

Other options might include routes below access/raised floor, in under-floor ducts, via poke through, cable ladders and perimeter facilities for placement of all cable to each workstation. If a requirement exists for any such subsystem, it will be necessary to contact the DFD to coordinate the installation.

Raceways should be sized based on a maximum fill of 40% (cable area / raceway area) and include spare capacity for future cable additions. Designers responsible for pathways and for cabling shall coordinate early in the design process and confirm design assumptions with the Agency and the DFD.

The horizontal distance from Telecommunication Room to Equipment Outlet shall not exceed 250 feet.

Distribution Considerations:
When determining the size of the pathway, the quantity and size of cables including spare capacity for growth, shall be considered. Ceiling distribution systems shall meet the following conditions:

- In areas where the ceiling is inaccessible, such as lock in type ceiling tiles, drywall or plaster, conduit from Equipment Outlet locations shall extend to the nearest accessible corridor area or cable tray.
- For a ceiling to be considered as "accessible" the ceiling tiles shall be the removable or lay in type and be placed at a maximum height of 11 feet above the floor.
- Adequate and suitable space is available in the ceiling area for the recommended distribution layout.
- Raceways are provided where required by codes or design.
- A minimum of 3 inches clear vertical space shall be available above the ceiling tiles for the distribution wiring and pathway.

Separation from Other Utilities
The DFD has adopted the recommendations of TIA-569-C "Commercial Building Standard for Telecommunications Pathways and Spaces" in its guidelines relating to separation between communications and other utilities.

Above Ceiling Installation :
The suspended ceiling support wire or rod shall not be used for supporting cables and wires. The wire or cable shall not be laid directly on the ceiling tile or rails.

Cables must be routed in such a way as to minimize interference with cross connect wiring on connector blocks and termination hardware. Manufacturer recommended accessories must be utilized to route cable away from the top and sides of the terminal blocks. Riser and horizontal distribution cables must enter the standoffs through the bottom.

All station related cables, wires, and equipment must be firmly held in place. Fastenings and supports must be adequate to support loads with ample safety factors. For large heavy riser cable, a structural engineer should be consulted. It is unacceptable for cables and wires to be lying on ceiling tiles or other objects that are not part of the Distribution System.

Cable Tray :
Where Cable Tray are planned above the suspended ceilings on each floor. All cable trays must be metal. Wire Mesh and Ladder types are acceptable on DFD projects.

- Loading of cable trays shall comply with the applicable electrical code and shall be properly fire stopped.
- Cable trays shall be grounded according to the TIA/EIA 607 standard and in conformity with the National Electrical Code.
- Cable trays must be routed in such a way as to not interfere with the operation or maintenance of any device along its path. The agency shall be held responsible for correcting any malfunction resulting from poor or improper cable installation.
- Conduits from rooms going into hallways shall protrude into the hallway ceiling from 1 to 2 inches and have plastic collars. Cables shall be supported with J-hooks or bridal rings from the conduit to the cable tray.
- Trays and conduit within the ceiling shall protrude into an equipment room for communications from 1 to 2 inches, without a bend above the 8 foot level.
- A means for controlling cable bending shall be provided where there is a discontinuity between cable tray sections or between cable tray and cable runway at the entrance to an equipment room.
- The inside of the cable tray shall be free of burrs, sharp edges or projections that can damage cable insulation.
- Cable trays shall not be used as walkways or ladders.

F. Work Area

General:
Each floor shall have workstations in need of telecommunications service. These guidelines recognize the importance of both voice and data telecommunications in a state owned or leased building.

A minimum of one Equipment Outlet shall be provided for each work area. It is becoming standard to have faceplates on opposing walls of an office, each faceplate containing one voice and two data outlets.

See the connectivity section below for direction as to cabling requirements to each EO.

Coordination with Other Trades
Communications A/E shall coordinate with the electrical designer to ensure synergy between the electrical and structured cabling plans.]

- Equipment Outlets shall be installed near an electrical outlet.
- Electrical and Equipment Outlets shall be positioned at the same level to provide a uniform appearance.
- Faceplate Material & Color of Equipment Outlets will be coordinated with the surrounding electrical outlets and face plates, or as may be dictated by the architect or the State.

G. Equipment Outlet (EO)

General:

The Equipment Outlet (EO) is the point at which a user device, such as a telephone or computer, attaches and forms a basic association to the building wiring system. This section describes the outlets consisting of face plates and termination jacks where the building wiring system terminates for connection, by a station outlet cable, to an end user device.

Equipment Outlet Rough-in

Rough-in for Equipment Outlets shall consist of a 4-11/16" square by 2-1/8" deep box ringed to a single-gang opening.

In general, each Equipment Outlet location shall be served by one 1" EMT conduit. The conduit shall extend from the box (1) to an accessible location above a suspended ceiling or (2) to the nearest accessible corridor or cable tray. The use of 1-1/4-inch conduitshould be considered may be The A/E should confirm requirements with the Agency and the DFD.

In correctional environments, cabling shall be in conduit along its entire length from the outlet box to the termination location. Individual pathways may be consolidated into larger conduits.

Exceptions to the requirement for 1" conduit include locations identified for minimal cabling such as wall-mounted telephone locations, wireless access points, mechanical system diagnostics, elevator phones, etc. A 3/4" conduit may be used in such instances.

All conduit ends shall be fitted with appropriate bushings.

All conduit is to be provided with a pull string to facilitate cable installation. Where new cable is installed, a pull string shall be co-installed.

Workstation Modular Furniture Locations:

At locations where Equipment Outlets are to be mounted in modular furniture, provide adequate capacity in the shared path from wall or floor to the furniture panels as follows:

- Provide minimum pathway equivalent to one, two inch access hole for each group of 8 workstations (assumes one EO per workstation). If each location has its dedicated conduit, the size of conduit to the location shall be a minimum of 1-inch.

Horizontal cable shall be protected from the point at which it exits the floor box, poke through device or wall-mounted junction box using the following methods:

- Flex Conduit
- Spiral Wrap
- Other Approved Means]

Outlet Mounting:

The Equipment Outlet (EO) should be easy to access if for no other reason than the user will form an opinion of the entire building wiring system based on accessibility and functionality of the EO according to the need. Also, ease of installing future technologies and additional functionality when needed will impress the end user.

The exact location of outlets and equipment will be governed by structural conditions and obstructions, or other equipment items. The final location of all outlets, panels, equipment, etc., shall be verified with the DFD.

All outlets and face plates shall be securely installed as a permanent fixture of the building or structure. Temporary outlet placement will not be permitted without prior approval of the DFD.

Typical installation configurations include:

- Flush-mounted to a recessed outlet box
- Surface mounted to walls. The surface mount unit that is part of a standalone box should be attached to a solid surface using screws.
- Cable raceway in modular furniture panels.
- Surface mounted to modular furniture
- Surface-mounted in a floor duct systems
- In a poke-through device
- In a floor-box
- Other approved means

This does not reflect all the possible mounting configurations that may be encountered.

Except as otherwise noted, outlet height - from finished floor to center line of outlet - will be as follows.

- Standard EO — 18" or to match other utilities per design
- Outlet for wall-mounted Telephone Set — 46"

H. Special Conditions and Applications

Future Section

VII. GROUNDING AND BONDING

A. General

Grounding systems are normally an integral part of the specific signal or telecommunications wiring system that they protect. Besides helping protect personnel and equipment from hazardous voltages, the grounding system may reduce the effect of electromagnetic interference (EMI) on the telecommunications wiring system. Improper grounding can produce induced voltages and those voltages can disrupt other telecommunications circuits.

The DFD standard for Grounding infrastructure for telecommunications systems is based on the ANSI/TIA Joint Standard "J-STD-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications". This standard specifies the requirements for a dedicated telecommunications grounding and bonding infrastructure. The DFD guidelines deviate from the standard in that the grounding system is to be configured with only one ground point. Key design requirements include:

- Telecommunications Main Grounding Busbar (TMGB) at the Building Entrance / Main Equipment Room.
- Telecommunications Grounding Busbar (TGB) at each Telecommunications Equipment Room.
- Telecommunications Bonding Backbone (TBB) conductor(s) from the TMGB to each TGB.
- For large buildings with multiple TBBs, a Grounding Equalizer (GE) shall be run between the TBBs at every third floor. Consult with DFD.

Attachment of ground conductor to busbar shall utilize a listed compression two hole lug or irreversible compression-type bus bar connector.

When compatible with required electrical codes, the grounding instructions and requirements of the equipment manufacturer should also be followed. The grounding requirements of the national or local codes or practices shall take precedence. The A/E shall ensure that the installation conforms with proper practices and requirements.

B. Topology and Components

The Telecommunications Main Grounding Busbar (TMGB) – a solid Copper plate, drilled to accept cable connectors - is the common point that all grounding connections for the building. The telecommunication Entrance Facility is the desirable location for the TMGB. The TMGB is to be bonded to the main Service Equipment Ground at the building's Electrical Entrance Facility (Service Entrance). The TMGB Is also to be bonded to Building Steel. . #3/0 AWG cable is to be used for all of the above connections.

Each Telecommunication Room and Equipment Room shall be equipped with a Telecommunications Grounding Busbar (TGB). Multiple TGBs within a room (if applicable) shall be bonded together with a conductor sized appropriately. The grounding backbone cable shall be "tapped" (exothermic weld or irreversible compression connector) and the connection made to the TGB using a #3/0 conductor. The grounding backbone IS NOT to be interrupted and connected through a TGB.

From the TMGB, #3/0 AWG copper grounding cable(s) to provide a ground path from the Main Equipment Room and from all TRs. Routes and the number of cables should be chosen to minimize the length of the cables. This grounding "backbone" cable shall be insulated [color options] and terminated on the TMGB using 2-hole lugs.

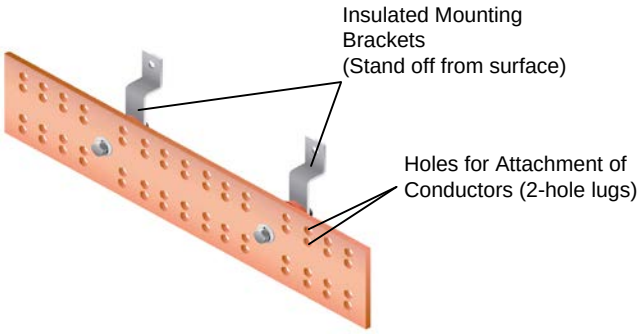

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Figure 9 – Telecommunications Grounding Busbar

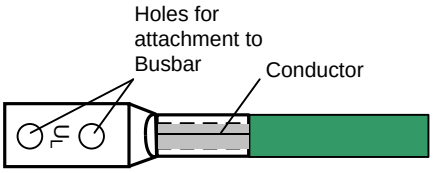

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Figure 10 – 2-hole Lug

Example topology for a multi-story building with multiple TRs on each floor is depicted below:

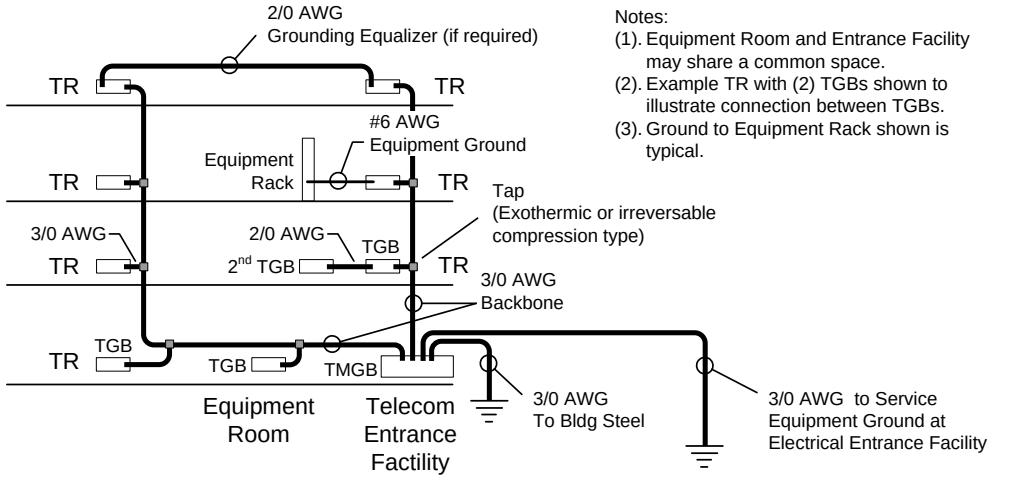

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Figure 11 – Telecommunications Grounding System Topology

TBB shall be continuous and not connected through Telecommunications Grounding Busbars (TGBs). The TGBs shall be bonded to the TBB via a tap-off conductor the same size as the TBB. The tap-off connection shall be irreversible type. Do not bond TBB or TGB to building steel at TGB location(s).

The TGB at each TR shall not be bonded to building steel nor a local electrical service panel. (Note that this is a deviation from the reference ANSI/EIA/TIA standard.)

Where multiple TRs serve a floor, the preferred topology is for two separate grounding backbone cables to be used – one for each "stack" of TRs – rather than a single backbone cable which serves both TRs.

Whenever two or more grounding backbone cables are used within a multistory building, the backbone cables shall be bonded together at the top floor and at a minimum of every third floor in between. The connection between the backbone cables – the "Grounding Equalizer" (GE) - shall be a #2/0 AWG conductor and used at the top floor and at a minimum of every third floor in between.

Key features of Cable and components to be used include the following. All components shall be listed as meeting UL 467 for "Grounding and Bonding Equipment".

- TMGB – Solid Copper plate 0.25" thick; minimum dimensions - 20" x 4". Drilled per ANSI Joint Standard J-STD-607-A to accept 2-hole lugs. Configured with Insulators and stand-off brackets to electrically isolate plate from mounting surface.
- TGB – Same as TMGB except minimum dimensions - 12" x 2".
- Grounding Conductors – Copper. When conductors are insulated, they shall be listed for the application. Insulation shall be green or marked with a distinctive green color.
- Lugs – Cast Copper alloy; 2 bolt type.

C. Grounding of Equipment and Cable Considerations

The following should be considered when designing the grounding system.

- The TMGB should be placed to provide for the shortest and straightest routing to the building's Electrical Entrance Facility (Service Entrance).
- TGBs should be located near the ground backbone cabling and to provide for the shortest and straightest routing of the grounding conductors.
- Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3ft in length, the conductors shall be bonded to each end of the conduit per ANSI J-STD-607-A.
- Ensure that grounding is available for cross-connect frames, patch panel racks, telephone equipment, data equipment and equipment required for maintenance and testing.
- All metal cable trays shall be bonded to ground. Cable tray shall not be used for a ground path.
- Shielded cables must be grounded. This includes cabling which terminates at the BET, Main Equipment Room, TRs, and TEs.

VIII. FIRE STOPPING

A. General

Fire stopping is intended to prohibit the spread of a fire and smoke from one location within a building to another. This means restoring the integrity of rated walls, floors, and ceilings when these barriers are penetrated. Penetrations include pipes, ducts, cables, sleeves, and conduits. A fire resistance rating uses the time (in hours) that a fire-stop "Assembly" or an architectural feature show an acceptable resistance to fire. The rating of the fire stop Assembly must meet (or be better than) the rating of the architectural feature that is penetrated.

It is difficult to standardize on an overall fire stop system because of the complex interactions of the materials, penetrating items, and construction assemblies. Since many proprietary solutions are available, only the engineering considerations are referenced.

Refer to the DFD specification Section 07 84 00 – Firestopping which includes important content relating to firestopping of communications and other low-Voltage applications.

IX. PROJECT PLANNING
Future Section

X. INSTALLATION PRACTICES – STRUCTURED CABLING
Future Section.

XI. LABELING
Future Section.

XII. TESTING AND DOCUMENTATION
Future Section.

XIII. DRAWING SYMBOLS
Future Section.

I. ACRONYMS AND GLOSSARY

ACRONYMS

A/D	Analog to Digital Conversion
ANSI	American National Standards Institute
AWG	American Wire Gauge
BDF	Building Distribution Frame
BEF	Building Entrance Facility
bps	Bits Per Second
CATV	Community Antenna Television
CCITT	Consultative Committee International Telegraph & Telephone
CMDF	Campus Main Distribution Frame
CO	Central Office (telephone)
CP	Consolidation Point
CPE	Customer Premises Equipment
CPU	Central Processing Unit
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CSU	Central Service Unit
D/A	Digital to Analog Conversion
DEMARC	Demarcation Point (between Service Provider- and Agency-owned facilities)
DF	Distribution Frame
DTE	Data Circuit Terminating Equipment
EIA	Electronics Industries Association
EMI	Electromagnetic Interference
ER	Equipment Room
FCC	Federal Communications Commission
FDDI	Fiber Distributed Data Interface
FDM	Frequency Division Multiplexing
FREQ	Frequency
ft	Feet
F/UTP	Un-shielded Twisted-Pair with overall Foil shield
GHz	Gigahertz (1,000,000,000 Hz)
GRD	Ground
HF	High Frequency
HVAC	Heating, Ventilation, and Air Conditioning
Hz	Hertz

IDF	Intermediate Distribution Frame
IEEE	Institute of Electrical and Electronic Engineers, Inc.
in	Inches
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
ISP	Inside Plant (Intra-building)
k	1,000
LAN	Local Area Network
lb	Pounds (weight)
lbf	Pounds (force)
LEC	Local Exchange Carrier
LoCAP	Low Capacitance, Low Loss Paired Cable
M (or Mega)	1,000,000
MAN	Metropolitan Area Network
MER	Main [Telecommunications] Equipment Room
MDF	Main Distribution Frame
MODEM	(analog) Modulate-Demodulate device
NIC	Network Interface Card/Controller
OSI	Open Systems Interconnection
OSP	Outside Plant (Inter-building)
PBX	Private Branch Exchange
PC	Personal Computer
PCM	Pulse Code Modulation
PoE	Power over Ethernet
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
RJ	Registered Jack
TDM	Time Division Multiplexing
TE	Telecommunications Enclosure
TR	Telecommunications Room
UL	Underwriters Laboratories
UTP	Unshielded Twisted Pair
VoIP	Voice over IP
WAN	Wide Area Network
WAP	Wireless Access Point

GLOSSARY

Air core cable	Cable or stub which does not contain waterproof encapsulate compound.
American Wire Gauge	A standard system for designating wire diameter.
Armor	Mechanical protector for cables.
Baseband	A signaling technique in which the signal is transmitted in its original form and not changed by modulation.
Bend radius	Fiber: The radius of curvature that a fiber can bend without breaking or causing excessive loss. Cable: The minimum radius to which a cable can be bent without the possibility of causing structural or electrical damage to the cable.
Bonding	The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.
Cabinet	A physical enclosure for rack mount equipment.
Cavity wall	A wall built of solid masonry units arranged to provide air space within the wall.
Coaxial cable	A cylindrical transmission line comprised of a conductor centered inside a metallic tube or shield, separated by a dielectric material, and usually covered by an insulating jacket.
Conduit	A pipe, usually metal, that runs either from floor to floor, or along a floor or ceiling, to protect cables. In the riser system, when riser rooms are not aligned, conduit is used to protect cable and provide the means for pulling cable from floor to floor. In a horizontal subsystem, conduit may be used between a riser closet and an information outlet in an officer or room. Conduit is also used for in-conduit campus distribution, where it is run underground between buildings and intermediate manholes and encased in concrete.
Connecting Block (Termination Block)	A flame retardant plastic block containing metal wiring terminals that establish an electrically tight connection between the cable and the cross connect wire.
Connector	A metallic device of suitable electric conductance and mechanical strength, used to splice the ends of two or more cable conductors, or as a terminal connector on a single conductor. Connectors usually fall into one of the following types: solder, welded, mechanical, compression.
Cross connect	A connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end.
Cross connect field	A color coded strip identifying the type of service carried on the cables terminated on a wire cross connect terminal block.
Demarcation ()DEMARC)	The terminal strip or block which is the physical interface between a Service Provider's lines and the lines going directly an agency-owned cable system.
Equipment Room for Communications	A room that contains one or more distribution racks and panels that are used to connect various cables together to form physical networks. Termination point for customer premises wiring and offering access to service personnel; generally serves a specific area.
Feeder Cable	An intermediate cable distribution line in a broadband coaxial network that branches off a main trunk cable.
Fiber optic cable	A cable consisting of one or more optical fibers protected by buffering material, inner cable components, central member, water blocking gel, rodent proof armor , and an outer jacket.

Ground	A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.
Interconnect	A connection scheme that employs connecting hardware for the direct connection of a cable to another cable without a patch cord or jumper.
Jacket	Pertaining to wire and cable, the outer sheath which protects against the environment and may also provide additional insulation.
Jumper	A wire to connect equipment and cable on a distributing frame.
Jumper wire	A short length of wire to route a circuit by linking two cross connect termination points.
Lightning Ground Cable	A specially stranded single conductor cable connecting lighting rods (air terminals) protecting buildings to adequate ground, such as grounding rods.
Modular Jack	A female-gender Modular Connector; typically 8-pin, 8-conductor type as used for structured cabling systems.
Modular Plug	A male-gender Modular Connector.
Plenum cable	A cable that is UL listed as having adequate fire resistance and low smoke producing characteristics for installation without conduit in ducts, plenums and other spaces used for environmental air, as permitted by NEC Articles 725-s(b) and 800-3(b). Cable specifically designed for use in a plenum, the space above a suspended ceiling used to circulate air back to the heating or cooling system in a building. Plenum cable has insulated conductors often jacketed with TEFLON or HALAR to give them low flame and low smoke producing properties.
Polyethylene	A thermoplastic material having excellent electrical properties. Abbreviated as "PE".
Premises Distribution System (Structured Cabling)	The transmission network inside a building or group of buildings that connects various types of voice and data communications devices, switching equipment and other information management systems together, as well as to outside communications networks. It includes the cables and distribution hardware components and facilities between the point where building wiring connects to the outside network lines back to the voice and data terminals in an office or other work location. The system consists of all the transmission media and electronics, administration points, connectors, adapters, plugs and support hardware between the building's side of the network and the terminal equipment required to make the system operational.
Raceway	A channel for holding electric wires or cables.
[Equipment] Rack	The vertical or horizontal open support, usually made of aluminum or steel, that is attached to floor or wall. Cables are laid in and fastened to the rack and its supporting equipment.
Rack-mount	Designed tobe installed on a frame (e.g. Equipment Rack or cabinet) as opposed to being mounted on the wall, or placed on the floor or a shelf..
RG/U	RG is the military designation for coaxial cable, and U stands for general utility.
RJ11	Common reference for 4- or 6-pin modular Jack/Plug
RJ45	Common reference for an 8-Pin, 8-Conductor (8P8C) modular Jack/Plug .
Shield	A sheet, screen, or braid of metal, usually copper, aluminum, or other conducting material placed around or between electric circuits or cables or their components to contain any unwanted radiation, or to keep out any unwanted interference.
Splice	The physical connection of two or more conductors to provide electrical continuity.

Transmission media	The various types of wire and optical fiber cable used for transmitting voice, data or video signals.
Twisted pair	Two insulated copper wire twisted together. The twists, or lays are varied in length to reduce the potential for signal interference between pairs.
Uninterruptible Power System	An on-line power system that generates load voltage 100% of the time.
Wireless Access Point (WAP)	
Waterproof cable	Cable or stub containing a waterproof filling compound that fills all available space in the core and prevents the entrance of water.

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II. STRUCTURED CABLING – DETAILS

Future Section.

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III. CABLE CLASSIFICATION TABLES

The following tables cover the classifications and designations pertinent to most State projects, as per the National Electrical Code (NEC):

A. Power Limited Cable:

Class	Article*	Description
FPL	760.61(C)	Fire alarm cable suitable for general purpose fire alarm use, with the exception of risers and plenums.
FPLR	760.61(B)	Fire alarm riser cable suitable for use in a vertical run in a shaft or from floor to floor and is listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.
FPLP	760.61(A)	Fire alarm plenum cable is suitable for use in ducts, plenums and other space used for environmental air, and is listed as having adequate fire resistant and low smoke producing characteristics.
PLTC	760.28(C)	Tray cable listed as being resistant to the spread of fire. The outer jacket shall be a sunlight and moisture resistant nonmetallic material.

B. Limited Use Cables:

Class	Article	Description
CL2X CL3X	725.61(E)	Cable suitable for use in dwellings and in raceways and shall be listed as being flame retardant.
CMX	800.154(E)	Communications cable suitable for use in dwellings and in raceways and shall be listed as being flame retardant.

C. General Purpose Cable:

Class	Article	Description
CL2 CL3	725.61(B)(3)	Suitable for general use with the exception of risers and plenums and shall be listed as being resistant to the spread of fire.
CL2R CL3R	725.61(B)	Suitable for use in a vertical run in a shaft or from floor to floor and shall be listed as having fire resistant characteristics capable of preventing the carrying of fire from floor to floor.
CL2P CL3P	725.3 725.61(A)	Suitable for use in ducts, plenums, and other space used for environmental air and shall also be listed as having adequate fire resistant and low smoke producing characteristics.

D. Communications [metallic] Cable:

Class	Article	Description
CM	800.170(D) 800.170(C)	Communications cable suitable for general purpose communications use with the exception of risers and plenums, and shall be listed as being resistant to the spread of fire.
CMR	800.170(E)	Communications riser cable suitable for use in a vertical run in a shaft and listed as having fire resistant characteristics capable of preventing the carrying of fire from floor to floor.
CMP	800.170(A)	Communications plenum cable suitable for use in ducts, plenums, and other space used for environmental air and listed as having adequate fire resistant and low smoke producing characteristics.

E. Fiber Optic Cable:

Optical fibers, by their nature, do not conduct electricity (e.g. are "Non-conducting"). Fiber optic cable types are classifieds by their construction allowing for installation in different environments and whether they contain conductive elements such as a shield, metal anti-buckling member or other metallic elements.

Class	Article	Description
OFC, OFCG	770.179 and 770.154	Fiber Optic Cable with Conductive elements; General purpose (not suitable for "Riser" or "Plenum" installation).
OFN, OFNG		Fiber Optic Cable with No conductive elements; General purpose.
OFCR		Fiber Optic Cable with Conductive elements; "Riser" rated.
OFNR		Fiber Optic Cable with No conductive elements; "Riser" rated.
OFCP		Fiber Optic Cable with Conductive elements; "Plenum" rated.
OFNP		Fiber Optic Cable with No conductive elements; "Plenum" rated.

IV. CODES AND STANDARDS

A. General

Construction in all areas of the State of Wisconsin is regulated by building codes and standards that are normally enforced by a local jurisdictional agency. Each state or local jurisdiction has its own methods for defining, implementing, and enforcing these codes and standards. Therefore, it is imperative that a thorough understanding of the regulations imposed by these codes and standards are developed early in the planning stage of any new construction that includes expansion or renovation of existing construction.

These codes and standards cover virtually all elements of the construction process, but not necessarily communications in detail. They govern the installation practices and materials used in the construction of communications systems. They do not always take into account additional considerations that may be required to provide protection of communications equipment, data processing equipment, and protection of data, from intrusion, induced noise, or other events that can disrupt vital operations.

B. Purpose

Building codes and standards ensure the quality of construction and to protect life, health, and property.

C. Standards Organizations

Several materials and test standards have been developed and published. Some manufacturers and local enforcement agencies have adopted many of these standards as evidence of acceptable quality in construction materials. The following is a partial list of standards organizations and a brief description of each:

American National Standards Institute (ANSI)
ANSI is the principal standards forming body in the United States. ANSI consists of over 300 standards committees or groups including the Data Communications Technical Committee responsible for Planning, Transmission Formats, Control Procedures, System Performance, Signaling Speed, Public and Private Data Networks, Grounding and other areas..

Electronic Industries Alliance (EIA)
The EIA was founded in 1924 as a trade organization to represent U.S. electronics manufacturers by focusing on hardware oriented issues. The EIA has produced over 400 publications and standards and developed the DTE/DCE interface standards, the RS-232 and RS449 interface standard.

Institute of Electrical and Electronic Engineers (IEEE)
The IEEE 802 Standards Committee consists of qualified engineers in electronics who establishes standards for the data communications industry focusing on Local Area Networks (LAN). The IEEE 802 Standards Committee is currently organized into subcommittees that have their own agendas and responsibilities for the development and documentation of technology standards

ISO: International Organization for Standardization
Promotes the development of international standardization with scientific, technological and economic activities. The Technical Committee 97, Information Processing, developed a seven layer communications reference model that allows multiple protocol and multiple vendor environments to interconnect and operate with one another.

Building Industry Consulting Service International (BICSI)
Publishes the Telecommunications Distribution Methods Manual (TDMM), which is a comprehensive collection of accepted practices in the design and methodology of communications systems. BICSI provides a competency examination for the professional designation as a Registered Communications Distribution Designer. This manual should be used as a reference only.

International Telegraph and Telephone Consultative Committee (CCITT).
The CCITT recommendations have the effect of law in most European countries and the U.S. closely follows the CCITT recommendations. Study groups are responsible for data communications interfaces, services, and transmission. The X.400 Electronic Mail Standard was developed from this organization and has attained widespread acceptance throughout the world.

Telecommunications Industries Association (TIA)
TIA is accredited by the American National Standards Institute (ANSI) to develop voluntary, consensus-based industry standards for a variety of ICT segments. TIA operates twelve engineering committees, which develop guidelines for private radio equipment, cellular towers,

data terminals, satellites, telephone terminal equipment, accessibility, VoIP equipment, structured cabling, data centers, mobile device communications, multimedia multicast, vehicular telematics, healthcare ICT, smart device communications, smart utility mesh networks and sustainable/environmental communications technologies.

Underwriters Laboratories (UL)
UL developed criteria for comparing communications cable called "UL's LAN Cable Certification Program". This certification program provides information regarding safety, performance and suitability of communications cable. UL's level program emphasizes actual performance criteria for transmission media. This allows for verification of suitability of cable for specific LAN applications such as 10/100BaseT and Gigabit Ethernet (GbE). The level descriptions are being printed on the sheaths of cable by manufacturers and the UL is responsible for overseeing and spot checking cable manufacturer's compliance to UL specifications.

D. Building Code and Standards Producers

The four major documents of building codes and standards are:

- Uniform Building Code - Produced by the International Conference of Building Officials (ICBO); 5360 South Workman Mill Road; Whittier, California 90601.
- The BOCA Basic Building Code - Produced by the Building Officials and Code Administrators International, Inc.; 17926 South Halsted Street; Homewood, Illinois 60430.
- Standard Building Code (SBC) - Produced by the Southern Building Code Congress International, Inc.; 900 Montclair Road; Birmingham, Alabama 35213.
- The National Building Code (NBC) - Produced by the American Insurance Association; New York, New York.
- National Electrical Code (NEC).

Many local building codes are based on the practices of the NEC and are a must for those responsible for providing a safe implementation of a communications system. Chapters 7 (esp Article 770) and 8 of the NEC handbook address issues of particular relevance to communications.

E. Fire Codes

The following standardized fire codes were developed and produced by the National Fire Protection Association (NFPA).

- Central Station Signaling Systems
- Local Protective Signaling Systems
- Auxiliary Protective Signaling Systems
- Remote Station Protective Signaling Systems
- Proprietary Protective Signaling Systems
- Automatic Fire protectors
- Protection of Electronic Computer Data Processing Equipment
- Lightning Protection Code
- Life Safety Code

F. Communication Codes and Standards

The National Electrical Safety Code (NESC®) "sets the ground rules for practical safeguarding of persons during the installation, operation, or maintenance of electric supply and communication lines and associated equipment. The NESC contains the basic provisions that are considered necessary for the safety of employees and the public under the specified conditions." This Code is published by the IEEE and is included in the National Bureau of Standards Handbook H43.

Communication wiring and equipment that is connected to the public switched network in the United States must comply with the requirements of Federal Communications Commission (FCC) Regulations, Part 68.

G. TIA/EIA Engineering Standards and Publications

The TIA/EIA Engineering Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers.

The purpose of the standards for Telecommunications to enable the planning and installation of a standards-based structured cabling system and supporting infrastructure for commercial buildings.

H. Enforcement of Codes and Standards

Codes and standards are usually enforced by the same local agency responsible for issuing building permits. In nearly all communities, the local government produces ordinances establishing building codes and standards for that jurisdiction. Some states have established statutory codes and standards that represent the minimum conditions under which any local government may permit construction to occur. In some areas, it is the responsibility of the local Fire Marshall to establish codes and standards and to enforce the codes for fire protection and detection within buildings. In some areas, it is necessary to comply with more than one body of codes and standards, requiring both city and county permits.

The Federal Government enforces the safety aspects of codes and standards as they apply to employee working conditions on employer premises through the Occupational Safety and Health Administration (OSHA)

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