**SECTION 27 10 00**

**STRUCTURED CABLING**

**BASED ON DFD MASTER SPECIFICATION DATED 09/03/24**

Notes to A/E:

This section has been written to cover most (but not all) conditions that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written.

It is recommended that you examine the Communications Structured Cabling System Standards & Design Guidelines document available on the DFD web site.

Edit all areas as applicable to meet the requirements of the project. Common options or features recognized by the DFD, or items where A/E input is needed are enclosed in [brackets] and/or <less-greater brackets>. Delete product types (Part 2) and related installation (Part 3) instructions that are not applicable to the project.

Editing instructions are included throughout the document (italic text; red if viewed/printed in color). Delete these instructions final printing.

The document is structured to automatically update the Table of Contents when printed or in response to an “Update Field” command (right mouse click on TOC opens menu) in MS-Word. Confirm that TOC has updated and is accurate of prior to printing. TOC entries are Hyperlinks and can be used to navigate the document.

Revision History:

In the on-line “DFD Document Library” Under “Master Specifications/Design Guidelines / Division 27 – Communications” see “Div. 27 Revision History”.

1. GENERAL

Scope

This section describes the products and execution requirements relating to furnishing and installation of Communications Cabling and Termination Components and related sub-systems as part of a Structured Cabling System for the project. The specified cabling may support “voice”, “data”, audiovisual and networked security applications as noted.

Work may also include removal and recycling of unused, un-documented and otherwise "abandoned" cables. Refer to project drawings and Part 3 of this Section under "Salvage Materials".

Included are the following topics:

[PART 1 - GENERAL](#_Toc127962034)

[Scope](#_Toc127962035)

[Related Work](#_Toc127962036)

[References](#_Toc127962037)

[Design Intent](#_Toc127962038)

[Quality Assurance](#_Toc127962039)

[Submittals](#_Toc127962040)

[Schedule](#_Toc127962041)

[PART 2 - PRODUCTS](#_Toc127962042)

[Backbone Twisted-Pair Copper Cable](#_Toc127962043)

[Backbone Fiber Optic Cable](#_Toc127962044)

[Horizontal Permanent Link](#_Toc127962045)

[Horizontal Twisted-Pair Cable](#_Toc127962046)

[Fiber Optic Splice Hardware](#_Toc127962047)

[Coaxial Cable (Wideband Video)](#_Toc127962048)

[Equipment Outlet](#_Toc127962049)

[Modular Patch Panel](#_Toc127962050)

[Horizontal Jumper Management](#_Toc127962051)

[Termination Blocks](#_Toc127962052)

[Fiber Optic termination Enclosure](#_Toc127962053)

[Flexible Nonmetallic Innerduct and Fittings](#_Toc127962054)

[Spares and Miscellaneous Materials](#_Toc127962055)

[PART 3 - EXECUTION](#_Toc127962056)

[General](#_Toc127962057)

[Equipment Rack Layout](#_Toc127962058)

[Salvage Materials](#_Toc127962059)

[Cleaning and Inspection](#_Toc127962060)

[Backbone Cable System Topology and Cable Size Requirements](#_Toc127962061)

[Cable Installation](#_Toc127962062)

[Equipment Outlet](#_Toc127962063)

[Innerduct](#_Toc127962064)

[Cable Termination](#_Toc127962065)

[Cross-connect Wiring and Patching](#_Toc127962066)

[Identification and Labeling](#_Toc127962067)

[Testing and Acceptance](#_Toc127962068)

[Documentation](#_Toc127962069)

[Training](#_Toc127962070)

[Warranty](#_Toc127962071)

Related Work

Applicable provisions of Division 1 govern work under this Section.

Edit as applicable to match project requirements. Delete reference to sections that do not appear in the project documents. Add other sections that apply.

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 01 12 16 – Work Schedule

Section 26 05 00 – Common Work Results for Electrical

Section 26 05 04 – Cleaning, Inspection and Testing of Electrical Equipment

Section 26 05 26 – Grounding and Bonding for Electrical Systems

Section 26 05 29 – Hangers and Supports for Electrical Systems

Section 26 05 33 – Raceway and Boxes for Electrical Systems

Section 26 05 36 – Cable Trays for Electrical Systems

Section 26 05 53 – Identification for Electrical Systems

Section 27 05 33.41 – Raceway and Boxes for Audio-Video Systems

Section 27 05 53 – Identification for Communications Systems

Section 27 08 00 – Commissioning of Communications

Section 27 11 00 – Communications Equipment Room Fittings

Section 27 11 13 – Communications Protection

Section 27 16 19 – Communications Patch Cords, Station Cords, and Cross-connect Wire

Section 27 41 00 – Audio-Video Systems

References

All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the Wisconsin Electrical Code and present manufacturing standards.

All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

Other applicable standards (plus applicable update bulletins and errata) are as follows:

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, -598-C, -606-B and TIA standards referenced therein. 568.3-D Fiber Optic
* ANSI/TIA-862-B – Structured Cabling Infrastructure Standard for Intelligent Building Systems
* ANSI/TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair (Cabling)
* IEEE/ANSI 142-1982 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
* ICEA publication S-80-576-2002
* ANSI/TIA-526-14-C and -526-7
* IEC 61300-3-35 - Fibre Optic Interconnecting Devices and Passive Components – Basic Test and Measurement Procedures
* TIA-607-C - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

Include the following for UW Madison-campus. Otherwise Delete.

* University of Wisconsin – Madison campus Technical Guidelines; <https://cpd.fpm.wisc.edu/technical-guidelines/>; Division 27 -– Communications.

Design Intent

General

The Structured Cabling System is based on a hierarchy of cables and termination locations.

All cables and related termination, support and grounding hardware, bonding, shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following sections.

Provide all labor and materials necessary to construct the system as described herein. This includes - but is not limited to - furnishing and installing cable, cable supports, innerduct, racking and termination components, termination, testing, labeling, and documentation.

Refer to Part 2 – PRODUCTS, Part 3 - EXECUTION and the project drawings for applicable cable and connectivity types and installation requirements.

[Add content indicating the planned re-use of existing or Agency-provided cabling and components if applicable.]

Backbone Cabling

Inter-Building Backbone Cabling - sometimes referred to as “Outside Plant (OSP)” - connects Main Cross-connect locations between buildings.

Intra-Building Backbone Cabling - sometimes referred to as “Inside Plant (ISP)” - connects the Main Cross-connect location (e.g., Main Equipment Room) with Horizontal Cross-connect location(s) (e.g., Telecom Room) in a building.

Horizontal Cabling

Horizontal Cabling System links the termination in the work area (Equipment Outlet (EO) or modular plug at a communications or security device) to the Horizontal Cross-connect serving the location (e.g., Telecommunications Room (TR) or Equipment Room (ER)). This cabling and the related connectors (both ends) is referred to as the “Permanent Link” in this section.

Security devices may include Card Access Credential Readers and/or Controllers and Video Surveillance cameras.

Quality Assurance

Manufactured Items

The manufacturer(s) of cabling and connectivity components shall be a company specializing in and having a minimum of five years documented experience in producing products similar to those specified in this and related sections.

Contractor Qualifications

The contractor shall have been in this line of business for a minimum of five (5) years and have successfully completed one or more projects of scope 50% or more of the magnitude specified by these documents.

Contractor shall have necessary certifications to provide for Guarantees as specified herein.

Edit (or delete) the following paragraph where existing termination or other components are to be re-used or where owner-furnished items are to be contractor installed.

Contractor shall be an active participant in Installers Program operated by Manufacturer of Cabling or Termination Components used. Contractor shall be a participant in this program at time of Bidding and remain so throughout project.

Contractor shall have on the project team at a minimum one (1) certified Installer trained by the manufacturer(s) of the cabling, hardware and accessories installed under this project.

At least (1) member of each test team shall be factory trained/certified in use of the test equipment. The project foreman shall have been factory trained in the use of the test equipment.

Mockups

Provide on request, mockups as applicable to verify selections made under Sample submittals, to demonstrate configuration, capacity and aesthetics and to set quality standards for fabrication and installation.

Mockups may include:

* Equipment Outlets, especially those for Wireless Access Points, surface-mounted, harsh environment and other unique conditions.
* Poke-Through Assemblies
* Floor Boxes.

Coordinate with Division 26 and AV (if applicable) in developing the mock-ups. Configure Mock-ups with all planned cabling, connectivity and devices for all disciplines planned at a location (Telecom/Data, AV, Electronic Security, Power).

Submittals

General

Under the provisions of Division 1, prior to the start of work, submit:

* Shop Drawings
* Contractor Qualifications
* Schedule of Values (part of GPC or STC submittal)

Group Submittals to include complete documentation of related systems, products and accessories in a single submittal.

Submittals shall be electronic format (ADOBE Portable Document format “.pdf”) copies of manufacturer datasheets.

Identify each proposed product with a mark or reproducible highlight.

Where multiple options for a particular product may apply (color, construction, features, etc.), identify the applicable option(s).

Where applicable, mark dimensions in units to match those specified.

Electronic links to product or manufacturer website pages may be included to supplement product datasheets but may not be used as a substitute for the required product datasheets.

The Engineer shall review the Submittals and through annotation and/or a cover sheet, provide comment.

Work shall not proceed without the Engineer’s review of the submitted items.

Submittals required during and in follow-up to construction (Test Plan, Test Results, Documentation, Record Documents, etc.) are detailed in Part 3.

Shop Drawing Submittal

Submit documents including:

* Manufacturer’s Product data for all products proposed indicating construction, materials, ratings, and all other parameters identified in Part 2 (Products) below. Structured Cabling submittal shall include Test Data confirming Horizontal Cabling Channel Performance.
* Manufacturer’s installation instructions.
* Upon request by the Engineer, one (1) two-foot section of each cable type to be utilized for final approval by the Engineer. This two-foot section shall have the manufacturer’s cable markings visible. Upon request, samples from every reel sent to the site shall be provided.

Contractor Qualifications

Edit (or delete) the following paragraph where existing termination or other components are to be re-used or where owner-furnished items are to be contractor installed.

Provide certification documents confirming contractor status as an active participant in Installers Program operated by Manufacturer of Cabling or Termination Components used.

Upon request, furnish project experience as identified under “Quality Assurance / Contractor Qualifications” above.

For each project listed provide:

* Name and location of installation.
* Date of initial operation of system by owner. (Minimum period of operation for referenced project shall be 12 months.)
* Owner's representative to contact and their telephone number.

Schedule of Values Submittal

As part of the General Prime Contractor (GPC) or Single Trade Contractor (STC) submittal, include in the breakdown of the proposed values for work to be performed:

* Materials (Cable, Connectivity, Equipment Racks, etc.)
* Installation (by building if applicable)
* Testing
* Documentation
* Training
* Additional categories as appropriate

Schedule

Coordinate Communications Equipment Room (Telecom/Data, AV and Electronic Security) readiness, testing and documentation to ensure agency staff has adequate time to deploy network equipment to support the project.

Interim testing and documentation may be required to support systems (e.g., Elevator, Mechanical, Security) that preceded building occupancy. Confer with agency and DFD prior to construction for additional direction.

Include the following ONLY if the identified specification Section is included in the document set. Otherwise, Delete the paragraph.

See specification Section 01 12 16 – WORK SCHEDULE, direction for coordination of Communications Equipment Room (Telecom/Data, AV and Electronic Security) readiness, testing and documentation to ensure agency staff has adequate time to deploy network equipment to support the project.

1. PRODUCTS

Backbone Twisted-Pair Copper Cable

General

Cable shall be UL-listed and be compliant with NEC Article 800 (Communications Circuits).

Cable shall meet the physical and electrical requirements of “Backbone Cable” as defined by the referenced TIA standards.

Cables shall incorporate 24 AWG solid, annealed, bare copper conductors. All conductors shall be continuous and splice free. Bridge taps are not allowed.

Conductors shall be insulated with a thermoplastic skin. Insulated conductors shall be stranded into pairs of varying lay lengths in order to minimize crosstalk.

Conductors shall be identified by the insulation color of each conductor. The color code shall follow the industry standard composed of ten (10) distinctive colors to identify 25 pairs in accordance with ICEA publication S-80-576-2002. Marking of each mate of the primary conductor in a pair with the color of that primary conductor is optional.

When cables of larger than 25 pairs are required, the core shall be assembled into 25-pair sub-units, each color coded in accordance with ICEA publication S-80-576. Cables with over 600 pairs shall have 25-pair binder groups combined into super units. These super units shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow and violet. Binder color code integrity shall be maintained wherever cables are spliced.

Cable pair count shall be as detailed on the Project Drawings.

Inter-Building Backbone Twisted-Pair Copper Cable

Installation of this cable type in underground duct is typical. Requirements for Direct burial occur on occasions. If this cable type is required, edit the first sentence. Include the requirement for armoring, regardless.

Cable shall be suitable for installation in underground duct.

A flooding compound shall be applied over the core and to all surfaces of the shield/armor to resist moisture entry and to inhibit corrosion.

The cable core shall be filled with a waterproofing compound and wrapped with a non-hydroscopic core tape.

The cables shall contain an overall corrugated, coated aluminum shield, which is electrically continuous over its entire length.

The cable shall be finished with a black polyethylene jacket, which is sequentially printed with a footage marker at regular intervals.

Intra-Building Backbone Twisted-Pair Copper Cable

Cable shall meet or exceed NEC Article 800 Type [CM] [CMR] [CMP] and be suitable for in-building installation. Jacket and cable construction shall be as required to meet the specified rating.

Cable transmission performance shall meet or be better than TIA Category 3 criteria.

Consider including the following content. Confer with agency and DFD to determine applicability.

Where cable pair counts exceed 50-pair, provide cable in 50-pair increments (separate cables). For example, if a 200-pair cable is specified on the plans, provide (4) 50-pair cables to allow for separation and future selective demolition.

The commercial availability of CMP-rated cabling that incorporates an overall shield is limited. Confirm availability before specifying.

Cable shall contain an overall corrugated, coated aluminum shield that is electrically continuous over its entire length.

Backbone Fiber Optic Cable

Edit to include only applicable cable type(s).

Aerial Fiber Optic Cable‑including self-supporting type and designs installed on a metallic messenger wire‑are unusual on DFD projects. Consult with DFD Engineer with questions on possible application of this cable type.

Specifying of certain tight-buffer Duct or Indoor/Outdoor cable designs meeting the tensile and temperature range requirements ~may~ be considered where such a design is perceived to offer termination, cable management or other advantages. Consult with DFD Engineer with questions on possible application of this cable type.

General

Cables shall incorporate Optical fibers meeting the specifications detailed in the sub-section(s) below. Backbone Fiber Optic Cable sizing (fiber count) shall be per Project Drawings.

Where a “Loose Buffer” cable type is specified, this may be interpreted as a “Loose Tube” or “Ribbon” design.

Duct Type Fiber Optic Cable

This cable shall be suitable for installation in underground duct.

Cable shall be a Loose Buffer design.

Cable materials shall be all dielectric (no conductive material).

*Exception*: Where armored cable is specified, that cable element may be metallic.

Confirm any requirement for armoring of this cable with the Agency. Consult with DFD Engineer if there are questions on its use.

[Cable shall incorporate a corrugated Steel Armor to provide for added protection and resistance to rodent attack.]

Cable shall incorporate a dry water-blocking material, to prevent the incursion of water into the cable.

Cable Jacket:

Material: Polyethylene (PE). PE shall be compounded to provide protection against the effects of ultraviolet light and limit the growth of fungus.

Cable jacket shall be free of holes, splits, and blisters.

The cable jacket shall be marked with the manufacturer’s name, words identifying the cable type (e.g., “Optical Cable” or “Fiber Optic Cable”), year of manufacture, and sequential length markings in feet. The marking shall be in a contrasting color to the cable jacket.

Temperature Range:

Storage: -40o to +70oC (no irreversible change in attenuation)

Operating -40o to +70oC

Installation 0o to +60oC

Humidity Range: 0 to 100%

Maximum Tensile Load:

During Installation: 2700 Newton (600 lb. force) (no irreversible change in attenuation)

Long Term: 800 N (180 lb. force)

Bending Radius:

During Installation: 20 times cable diameter

No Load: 10 times cable diameter

Direct Buried Type Fiber Optic Cable

This cable shall be suitable for direct burial.

Cable shall be a Loose Buffer design.

Cable shall incorporate an interlocking Steel Armor to provide for resistance to rodent attack. All other cable materials shall be dielectric (no conductive materials).

Cable shall incorporate a dry water-blocking material, to prevent the incursion of water into the cable.

Cable Jacket:

Material: Polyethylene (PE). PE shall be compounded to provide protection against the effects of ultraviolet light and limit the growth of fungus.

Cable Jacket shall be marked with the manufacturer’s name, words identifying the cable type (e.g., “Optical Cable” or “Fiber Optic Cable”), year of manufacture, and sequential length markings. The actual length of the cable shall be within -0/+1% of the length markings. The marking shall be in a contrasting color to the cable jacket.

Temperature Range:

Storage: -40o to +70o C (no irreversible change in attenuation)

Operating -40o to +70o C

Humidity Range: 0 to 100%

Maximum Tensile Load:

During Installation: 2700 Newton (600 lb. force) (no irreversible change in attenuation)

Long Term: 800 N (180 lb. force)

Bending Radius:

During Installation: 20 times cable diameter

No Load: 10 times cable diameter

Indoor Type Fiber Optic Cable

This cable shall be suitable for installation in building riser systems, in conduit, in cable tray or in innerduct.

Tight Buffer designs are preferred for intra-building backbone cabling. Loose Buffer is acceptable only where required by an unusually high fiber-count. Confirm any such requirement with the DFD Engineer.

Cable shall be a Tight Buffer design.

Cable materials shall be all dielectric (no conductive material).

*Exception*: Where armored cable is specified, that cable element may be metallic.

Non-conductive options are typical. Select Conductive option when the cable incorporates an overall metallic armor. General Purpose option can also be considered if applicable.

Cable Rating: [OFNR (Optical Fiber Non-Conductive Riser)] [OFNP (Optical Fiber Non-Conductive Plenum)] [OFCR (Optical Fiber Conductive Riser)] [OFCP (Optical Fiber Conductive Plenum)] or Code-permitted substitute.

Cable Jacket: As required for rating.

Cable jacket color shall indicate fiber type per TIA-598.

OM1 (62.5/125 Multimode) ORANGE

OM3 (50/125 LASER-optimized Multimode) AQUA

OS2 (Single-mode) YELLOW

The cable jacket shall be marked with the manufacture’s name, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet.

Confirm any requirement for armoring of this cable with the Agency. Consult with DFD Engineer if there are questions on its use.

[Cable shall incorporate an interlocking metallic Armor to provide for added protection.]

Temperature Range

Storage: -40o to +70oC (no irreversible change in attenuation)

Operating 0o to +70oC

Humidity Range: 0 to 100%

Max. Tensile Load

* ≥ 12-fibers

During Installation: 1332 Newton’s (300 lb. force) (no irreversible change in attenuation)

Long Term: 600 N (135 lb. force)

* < 12-fibers

During Installation: 1000 Newton’s (225 lb. force) (no irreversible change in attenuation)

Long Term: 300 N (67 lb. force)

Bending Radius

During Installation: 20 times cable diameter

No Load: 10 times cable diameter

Where installation conditions and economics merit their use (e.g., to avoid the need for conduit or a transition between cable types), Indoor/Outdoor cables may be used. Engineer should be able to defend the selection of this cable type. Confirm any requirement for armoring of this cable with the Agency. Consult with DFD Engineer if there are questions on its use.

Indoor/Outdoor Fiber Optic Cable

Cables shall be suitable for installation in multiple environments including underground duct and inside the project building(s).

Cable shall be a loose-tube design.

Cable materials shall be all dielectric (no conductive material).

Confirm any requirement for armoring of this cable with the Agency. Consult with DFD Engineer if there are questions on its use.

[Cable shall incorporate an interlocking metallic Armor Tape to provide for added protection and resistance to rodent attack.]

Non-conductive options are typical. Select Conductive option when the cable incorporates an overall metallic armor. General Purpose option can also be considered if applicable.

Cable Rating: [OFNR (Optical Fiber Non-Conductive Riser)] [OFNP (Optical Fiber Non-Conductive Plenum)] [OFCR (Optical Fiber Conductive Riser)] [OFCP (Optical Fiber Conductive Plenum)] or Code-permitted substitute.

Cable shall incorporate a blocking material, swell able yarn, or other means to prevent the incursion of water into the cable.

Cable construction shall be as required to meet the specified rating.

The Cable Jacket sheath shall be marked with the manufacturer’s name, words identifying the cable type (e.g., “Optical Cable” or “Fiber Optic Cable”), year of manufacture, and sequential length markings. The actual length of the cable shall be within -0/+1% of the length markings. The marking shall be in a contrasting color to the cable jacket.

Temperature Range:

Storage: -40o to +70oC (no irreversible change in attenuation)

Operating -40o to +70oC

Installation 0o to +60oC

Humidity Range: 0 to 100%

Maximum Tensile Load:

During Installation: 1350 Newton (312 lb. force) (no irreversible change in attenuation)

Long Term: 400 N (85 lb. force)

Bending Radius:

During Installation: 20 times cable diameter

No Load: 10 times cable diameter

Optical Fiber Specifications - Backbone Cable

Edit the following sections to match the fiber type(s) to be included in the project.

General

The fiber count in each cross-section will vary. For quantities and other design information, refer to the Project Drawings.

All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification. Factory optical fiber splices are not allowed.

All fibers shall have been subjected to a minimum tensile proof test by the fiber manufacturer equivalent to 100-kpsi.

All fibers in each cable shall be guaranteed to meet the stated specifications.

Multi-mode Optical Fibers (62.5-micron core)

Fiber Type Multi-mode; doped silica core surrounded by a concentric glass cladding.

ISO/IEC type OM1

Fiber shall meet requirements of TIA-492AAAA Detail Specification for 62.5/125-μm, Class 1a Graded-Index Multimode Optical Fibers.

Fiber Coating Diameter 250 µm (nominal) primary coating; 900 μm (nominal) secondary coating where tight buffer cable design is specified.

All coatings shall be mechanically strippable without damaging the optical fiber.

Attenuation (max. dB/km @ 23±5 °C)

@ 850 nm 3.5

@ 1300 nm 1.5

Bandwidth (min. MHz\*km)

@ 850 nm 200

@ 1300 nm 500

No multi-mode optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths.

Specifying of higher-performing multimode fiber types (e.g., Wide Band Multimode Fiber, OM4) ~may~ be considered where such a design is perceived to offer needed advantages to the agency communications system design. Consult with DFD with questions on possible application of this fiber type.

Multi-mode Optical Fibers (50-micron core) LASER-Optimized

Fiber Type Multi-mode; doped silica core surrounded by a concentric glass cladding.

 ISO/IEC type OM3

Fiber shall be meet requirements of TIA-492AAAC Detail Specification for 850 nm LASER-Optimized, 50/125 μm, Class 1a Graded-Index Multimode Optical Fibers.

Fiber Coating Diameter 250 µm (nominal) primary coating; 900 μm (nominal) secondary coating where tight buffer cable design is specified.

All coatings shall be mechanically strippable without damaging the optical fiber.

Attenuation (max. dB/km @ 23±5 °C):

@ 850 nm 3.5

@ 1300 nm 1.5

Bandwidth (min. MHz\*km):

OFL 1500 @ 850 nm; 500 @ 1300 nm

EMB 2000 @ 850 nm

No multi-mode optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths.

Single Mode Optical Fibers

Fiber Type Single mode; doped silica core surrounded by a concentric glass cladding.

Fiber shall be meet requirements of:

TIA-492CAAB - Detail Specification for Class IVa Dispersion-unshifted (non-shifted) Single-Mode Optical Fibers with Low Water Peak (equivalent to ITU G652.D.)

IEC 60793-2-50 Type B1.3

Cabled Fiber:

Indoor / Tight-Buffer - ISO/IEC type OS1 (sometimes manufacturer mis-identified as OS2)

Outdoor / Loose-Buffer - ISO/IEC type OS2

Fiber Coating Diameter 250 µm (nominal) primary coating; 900 μm (nominal) secondary coating where tight buffer cable design is specified.

All coatings shall be mechanically strippable without damaging the optical fiber.

Fiber Attenuation (max. dB/km @ 23±5 °C)

 Intra-Building (ISP) Inter-Building (OSP)

@ 1310 nm 1.0 0.65

@ 1550 nm 1.0 0.65

No single mode optical fiber shall show a point discontinuity greater than 0.1 dB at the specified wavelengths.

Horizontal Permanent Link

Confer with Audio-Video and Electronic Security Systems designer(s) to identify Structured Cabling requirements for those systems that should be considered in this section.

General

The Horizontal Cable System is based on the installation of 4-pair, copper twisted-pair cables from the Equipment Outlet to the Horizontal Cross-connect (wiring hub). The combined cable and termination hardware is referred to as the “Permanent Link”.

Unshielded Twisted-Pair (UTP) is the default choice for the horizontal cable unless noted otherwise.

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.

Cable and Termination Components (Jack, Patch Panel / Wiring Blocks) are specified to function as a System. The compatibility of the Cable to be installed with the proposed termination components shall be recognized and documented by the Termination Component Manufacturer.

All Horizontal Link Cable shall be of the same manufacturer throughout the project.

All Horizontal Link connectivity components shall be of the same manufacturer throughout the project.

*Exception*: Where identified for 4-pair cable termination at a security device (e.g., camera, card access controller) or wireless access point, Modular Plug may be from a manufacturer other than that providing other Horizontal Link connectivity.

Application

There shall be no distinction between Horizontal Cables designated for “DATA” and “VOICE” (Telephone and/or other analog) applications.

Include the sentence above or below. Delete the other. Where there is no intended distinction, it is acceptable to identify connectivity intended for “Voice” application on drawings to facilitate agency reviews.

Separate Horizontal Cables designated for “DATA” and “VOICE” (Telephone and/or other analog applications) shall support each application.

Horizontal Cables for network-type Security devices (e.g., IP Video Surveillance Camera), if applicable, are considered “Data” cables for the purpose of this specification.

Performance

Where Cable, Component and Permanent Link performance is specified to “Exceed Category 6”, performance shall be defined as follows:

* Manufacturer’s published literature shall document performance margins over worst-case ANSI/TIA-568-C.2 Category 6 Channel requirements. Channel – as tested – shall include 4-connections (minimum). Data shall be verified by an independent source (e.g., ETL. Intertek).

Performance Margins shall be greater than zero (0) at all frequencies up to and including 250-MHz.

*Exceptions*:

1. Where a Modular Plug is identified for 4-pair cable termination at a device, the above requirement for performance margins does not apply. Performance of the link shall meet the requirements of the standard (e.g., Category 6).
2. For Outdoor and “Wet” Locations, performance margins over standards-compliant limits do not apply.

Where Cable, Component and Permanent Link performance is specified to “Meet Category 6A”, performance shall be defined as follows:

* Meet or exceed ANSI/TIA Category 6A criteria.

Performance Margins exceeding those defined by the referenced standard are not required.

Cable and connecting components that comprise the “Permanent Link” shall meet or exceed the requirements to deliver power as defined by IEEE 802.3 Ethernet standards as follows:

* Security Cameras, Wireless Access Points and Digital Signage – 802.3bt (PoE++); 90W
* All other locations – 802.3at (PoE+); 30W

Project Requirements

Edit to match project requirements and Agency standards.

If there is no Voice/Data distinction, delete “Voice” items.

Cable shall be listed as being suitable for use in environment defined.

Cable Rating:

* Indoor: [CM] [CMR] [CMP] or approved substitutes as defined by the NEC. CATV equivalents apply for coaxial cable where specified.
* Outdoor or Indoor/Outdoor: [CM] [Listing not required. Install such cables in conduit except where allowed by Code or otherwise indicated on drawings.]

Cable and connectivity type, performance and features for included applications are as follows:

Category 6 performance is the DFD default for workstation links. Category 6A may be acceptable for special project types where the added cost is justified by anticipated performance needs. Confer with DFD.

* Workstation Link (to Equipment Outlet)

Performance Exceed Category 6

Cable type 4-pair UTP

Cable Jacket Color

Data [COLOR]

Voice [COLOR]

Modular Jack Pinning and Color

Data [T568A] [T568B]; Color [COLOR]

Voice [T568A] [T568B]; Color [COLOR]

Cable performing to Category 6A limits is DFD default for Wireless Access Point locations.

Suggest considering F/UTP and Discontinuous Foil cable types. Confirm agency preference and/or discuss with DFD.

* Wireless Access Point (WAP) Location

Performance [Exceed Category 6] [Meet Category 6A]

Cable type [4-pair UTP][4-pair F/UTP][4-pair w/ Discontinuous Foil over UTP]

Cable Jacket Color [COLOR]

Terminate in 8P8C Modular [Jack] [Plug].

Modular Jack/Plug Pinning and Color

[T568A] [T568B]; Color [COLOR]

* Security Camera Location

Performance [Exceed Category 6] [Meet Category 6A]

Cable type

 Indoor location [4-pair UTP] [4-pair F/UTP]

 Outdoor location [4-pair UTP] [4-pair F/UTP] (Equipment Outlet inside building)

Cable Jacket Color [COLOR]

Terminate in 8P8C Modular [Jack] [Plug].

Modular Jack/Plug Pinning and Color

[T568A] [T568B]; Color [COLOR]

* Security Card Access Controller Location

Performance Exceed Category 6

Cable type 4-pair UTP

Cable Jacket Color [COLOR]

Terminate in 8P8C Modular [Jack] [Plug].

Modular Jack/Plug Pinning and Color

 [T568A] [T568B]; Color [COLOR]

* Outdoor and “Wet” Location(s)

Performance [Meet Category 5e][Meet Category 6][Meet Category 6A]

The requirement for performance margins as specified in the above Article “HORIZONTAL PERMANENT LINK” does not apply.

Cable type [4-pair UTP][4-pair F/UTP]

Cable Jacket Color N/A; Typically, Black or Gray

Modular Jack Pinning and Color

Same as Workstation Link

Horizontal Twisted-Pair Cable

General

All Cables and Termination hardware shall be technically compliant with and installed in accordance with the referenced ANSI/TIA documents and perform as required to provide the margins stated herein.

All cables shall be suitable for installation in the environment defined.

Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code and shall meet the specifications of NEMA (low loss), UL 444, and ICEA.

Construction:

Horizontal Cables shall be constructed of individually twisted pairs with 24-AWG (Category 5e) or 23-AWG (Category 6 and 6A) - as applicable - insulated solid copper conductors.

Pairs shall be identified by a banded color code in which conductor insulation is marked with a dominant color and banded with a contrasting color as follows:

Pair 1: White-Blue / Blue (or Blue/White)

Pair 2: White-Orange / Orange (or Orange/White)

Pair 3: White-Green / Green (or Green/White)

Pair 4: White-Brown / Brown (or Brown/White)

Indoor Applications

Cable performance shall be as required to meet the Permanent Link and Channel performance as specified in the above Article “HORIZONTAL PERMANENT LINK”.

Cable Rating shall be as identified in the above article “HORIZONTAL PERMANENT LINK”.

Cable Jacket color(s) shall be as identified in the above article “HORIZONTAL PERMANENT LINK”.

Cable shall be packaged in a way that minimizes tangling and kinking of the cable during installation. Examples are open reels or packages that incorporate a rotating reel.

Include the following sub-Article if the project includes instances where cabling is routed through environments considered as “wet” under applicable Code or where the cable is installed outside in an underground duct. Select correct heading and edit content to match project requirements.

[Indoor “Wet Locations”][Indoor/Outdoor][Outdoor] Applications

Cable shall be suitable for installation:

* Outdoors in underground duct and for aerial lashing.
* [Indoors including wet locations such as below grade duct or flood-prone areas.]

Cable Performance: As identified in the above article “HORIZONTAL PERMANENT LINK”.

Cable Rating shall be as identified in the above article “HORIZONTAL PERMANENT LINK”.

Construction

* Jacket: UV/sunlight-resistant. Cable Jacket color(s) requirement is waived; this cable type is typically black or gray.
* Fully water-blocked / flooded core.
* Overall Shield/Armor. [N/A][Corrugated copper-clad steel armor; applied with an overlap. Electrically continuous.][Polymer coated smooth aluminum tape shield; applied with an overlap. Electrically continuous.]

Temperature Range:

Operating: -40°C to +60°C (-40°F to +140°F)

Installation: -20°C to +60°C (-4°F to +140°F)

Horizontal Cable Termination

Refer to Part 2 articles “EQUIPMENT OUTLET”, “MODULAR PATCH PANEL” and “TERMINATION BLOCKS”.

Termination hardware performance shall be as required to meet the criteria defined in “HORIZONTAL CABLING / Performance” above.

Include the following sub-Article if the project includes instances where cabling is terminated in a modular jack in a work area and the cabling then extended – through an interconnect at that jack - to the Equipment Outlet. Examples include lab areas served by an umbilical, modular furniture, conference table or “island” type design furniture. The jack at the interconnection point jack constitutes a Consolidation Point (CP) under the standards.]

Zone Cable Assembly

Where the project includes instances where cabling is terminated in a modular jack in a work area and the cabling is then extended‑through an interconnect at that jack‑ to the Equipment Outlet, the jack at the interconnection point jack constitutes a Consolidation Point (CP) under the standards. Examples include lab areas served by an umbilical, modular furniture, conference table or “island” type design furniture.

Cable Assembly from Consolidation Point (CP) to Equipment Outlet (EO) shall be considered as part of the Horizontal Permanent Link.

Cable and connecting components shall be from the same manufacturer of the products used in the Horizontal Cable and meet the performance requirements for those cables and connecting components as specified herein.

Construction:

* 4-pair, UTP, solid conductors. Listing (e.g., CMR or CMP) to match Horizontal Cable.
* Plug-to-Jack configuration; 8P8C.
* T568A/B Pin/Pair Assignment.
* Modular Plugs shall be a Snag-less design and incorporate Boot/Strain-relief.

Fiber Optic Splice Hardware

Splices in fiber optic cable are allowed a) where shown to be economically advantageous to make a required transition between cable types (e.g., non-rated Outdoor to rated Indoor) or b) where used to splice factory-terminated connector assembly (“pigtail”) onto multi-fiber cable. It is DFD preference, however, that there be no splices. Confirm any other condition where splicing is considered with the DFD Engineer. Edit Article to match project requirements.

General

Splices in fiber optic cables shall be allowed only where specifically identified on drawings or specified herein.

Splicing Hardware shall be:

Designed specifically for use in the splicing of fiber optic cables.

Sized to accommodate the cable type(s) and counts planned at each splice location.

Incorporate a clamping mechanism to secure the incoming cables, to prevent movement (e.g., bowing, pistoning, or breaking) of the cable central member, and to prevent cable sheath slip or pullout.

Splicing Hardware shall accommodate Splice Trays suitable for the splicing type specified.

Separate Splice Tray shall be used for each fiber bundle (e.g., buffer tube) unless otherwise approved by the Engineer.

Splice Hardware (incl. Enclosure and/or Closure and Splice Trays) shall be designed to organize adequate slack to allow for re-splicing.

Splice Trays shall be individually accessible.

Fiber splices shall be individually secured and protected per cable manufacturer’s recommendations.

Splice Tray dimensions shall not result in spliced fibers being subjected to a bend radius smaller than minimums recommended by the cable manufacturer.

Splice Closure

Splice Closure shall be used at locations where a sealed assembly is required and/or where identified on project drawings.

The splice closure housing shall:

Be non-metallic.

Be resistant to solvents, chemicals and other materials to which it might be exposed in normal applications.

Be resistant to stress cracking and creep.

Encapsulation shall not be required to be made moisture tight and resist water penetration.

Closure and sealing components (e.g., gaskets, grommets, O-rings) shall meet Telcordia GR-771-CORE, Issue 1 (1994) requirements relating to entry of water into the closure after thermal aging, water immersion and freeze/thaw cycles.

Splice Closure shall be re-enterable for system expansion or repair.

The splice closure shall incorporate hardware to facilitate the bonding and grounding of metal components in the closure and, if applicable, metallic cable elements (e.g., armor).

[Where used in an aerial application, the splice closure shall have available the necessary hardware to attach and secure the closure to an aerial strand.]

Splice Enclosure (Indoor)

Splice Enclosure shall be used at indoor locations where a sealed assembly is not required, where used to house splices associated with splicing of factory-prepared cable assemblies (“pigtails”), Termination Cassettes and/or where identified on project drawings.

Enclosure shall be rack- or wall-mounted per project drawings.

Units designated for rack-mounting shall incorporate mounting brackets to fit into a 19-inch equipment rack with EIA/TIA universal hole spacing.

Enclosure shall provide storage and protection of fiber splices.

Enclosure shall allow cables and jumpers entry from left and right sides.

Rack-mounted enclosures at a termination location shall incorporate top and bottom removable access panels at the rear of unit for vertical pigtail entry from the Enclosure to Connector Panel enclosure. Integrated splice and connector housings are acceptable for small fiber counts.

Include locks only upon Agency request.

[Unit shall be lockable.]

Coaxial Cable (Wideband Video)

Inter-building Backbone Coax Cable (Outdoor)

Cable shall be hardline type (half-inch; Type .500) and be suitable for trunk distribution.

Construction:

* Jacket Material PE
* Center Conductor Material Copper-clad aluminum
* Construction Type Swaged
* Dielectric Material PE
* Outer Conductor Material Aluminum

Impedance - 75 Ohms

Cable shall incorporate a flooding compound.

Cable Attenuation shall be documented to 1 GHz (1000 MHz) or higher.

Intra-building Backbone Coax Cable

Use of RG-11 as intra-building coax backbone is default unless site standards or other factors merit use of 0500 hardline coax. Confirm any use of .500 cable for intra-building application with DFD Engineer.

Cable shall be [RG-11 Quad Shield type cable] [.500 trunk distribution type cable].

Cable shall be listed as being suitable for use in environment defined and shall meet a [CMR/CATVR] [CMP/CATVP] rating (or approved substitutes as defined by the NEC).

Include the following for RG-11.

Construction:

* RG-11, Quad Shield
* Center Conductor – 14 AWG Copper-clad Steel
* Outer jacket – As required for rating.

Impedance - 75 Ohms

Cable Attenuation shall be documented to 1 GHz (1000 MHz) or higher.

Horizontal "TV" Coax

RG-6 is appropriate for most applications. Consider RG-11 where attenuation of longer runs is a concern.

Cable shall be RG-6 type; Quad-shield.

Cable Rating shall be as identified in the above article “HORIZONTAL PERMANENT LINK”.

Construction:

* RG-6, Quad Shield
* Center Conductor – 18 AWG Copper-clad Steel
* Outer jacket – As required for rating.

Impedance - 75 Ohms

Cable Attenuation shall be documented to 1 GHz (1000 MHz) or higher.

Equipment Outlet

Edit this Article to fit the project.

Content assumes the use of copper twisted-pair and coaxial cabling. Inclusion of Fiber Optic Cable as part of the horizontal media (e.g., fiber-to-the-desk) is unusual for DFD projects. Specifications are available upon request from the DFD.

General

Horizontal cables shall each be terminated at their designated workstation location in the connector types described in the sub-sections below. Included are Modular Jacks, [Fiber Optic Connectors][and Coaxial Connector assemblies]. These connector assemblies shall snap into a mounting frame. The combined assembly is referred to as the Equipment Outlet (EO).

EO mounting configurations shall be as follows:

Flush in new or where existing boxes are in place.

Mounted on Modular Furniture (base panel) - Modular Furniture Type shall be defined prior to construction.

Mounted in a Floor Box or Poke-Through Assembly.

Edit to match project requirements. Faceplates with fewer openings to match the installed cable quantity can be considered where including blanks is an aesthetic or security concern.

The Equipment Outlet Frame‑wall- and furniture-mount assemblies‑shall accommodate:

A minimum of four (4) Modular Jacks, Fiber Optic Connectors and/or Coaxial Connectors when installed on a wall-mounted assembly.

A minimum of two (2) Modular Jacks and/or Coaxial Connectors when installed on modular furniture. Design shall accommodate bend radius of installed cables.

The outlet frame shall incorporate a mechanism for adjusting the surface plate to a plumb position.

Refer to the project drawings for configuration requirements for mounting in a Floor Box or Poke-Through Assembly.

Connector mounting in the faceplate/frame shall be as follows. Where “Angled” orientation is specified, connector exits the faceplate at a (approx.) 45-degree angle with the connector facing the floor.

Wall-mount: [Flush] [Angled]

Furniture-Mount: [Flush] [Angled]

Floor Box or Poke-Through Assembly: Flush

The same orientation and positioning of Jacks and Connectors shall be utilized throughout the installation. Prior to installation, submit the proposed configuration for each EO type for review by the Engineer.

Wall Mount Outlet Faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

Unused jack positions shall be fitted with a removable blank inserted into the opening.

Faceplate of the EO shall be constructed of [High Impact Plastic] [Stainless Steel].

If stainless faceplates are used, delete the following sentence.

Faceplate Color shall (1) match other utilities in the building or (2) when installed in Surface Raceway (if applicable), match the color of the Raceway.

If fiber optic cabling is part of the horizontal cabling, include the following paragraph. Otherwise, delete.

Different frame designs for locations which include fiber optic cabling verses those which terminate only Copper Cabling (UTP and/or Coax) are acceptable. Outlets which incorporate optical fiber shall be compliant with the above requirements plus:

Be a low-profile assembly.

Incorporate a mechanism for storage of cable and fiber slack needed for termination.

Position the fiber optic couplings to face downward or at a downward angle to prevent contamination.

Incorporate a shroud that protects the optical couplings from impact damage.

Use the following paragraph if Agency/Owner Requires Dust Covers that remain with the jack when in use, even in Selected Areas. Otherwise, delete. Confirm this requirement and possible options with DFD Engineer.

Modular Jack design shall include a Dust Cover which remains with the jack assembly when the jack is in use. No damage to the Jack pinning shall result from insertion or removal of these covers. Dust covers, which result in deformation of the jack pinning, shall not be accepted.

In areas where protection beyond a simple dust cover is required (e.g., in dirty or industrial areas, wet labs or areas where a “wash down” is possible), consider the use of “industrial” products which carry IP-66/NEMA 4 ratings. Confer with DFD Engineer for guidance and product examples.

Outlet for Dirty or Harsh Environment

Construction:

* Form: 2-gang.
* Faceplate Material: Stainless Steel
* Capacity: (1) or (2) connector assemblies as required by location.
* Jack Configuration/Mounting: Flush mount; Includes mount for dust cap.

Configured with dust cap which is tethered to faceplate when not in use.

Meets IP67 sealing requirements.

Outlet for Wall-mounted Telephone Sets

Outlets intended for wall-mounted telephone sets shall be installed where identified ("W") on the Project Drawing(s). The Wall Plate shall be of Stainless-Steel construction, accommodate one (1) modular jack as previously defined, mounted on a standard single gang outlet box or bracket and include mating lugs for wall phone mounting.

4-pair Copper Connector (Modular Jack)

Connector type for 4-pair, copper twisted-pair cabling shall be an 8-pin, 8-conductor (8P8C) Modular Jack.

The interface between the jack and the 4-pair cable shall be an insulation-displacement type contact. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination to meet performance requirements.

Modular Jacks shall be UL verified and listed.

Modular Jack spring wire contacts shall have a minimum of 50 micro-inches of gold plating.

Modular Jack performance shall be as required to meet the specified Permanent Link and Channel performance as specified in the above Article “HORIZONTAL PERMANENT LINK”.

Connector type used for 4-pair F/UTP cabling‑if applicable‑shall match the requirements described above plus:

* Be of all metal construction or incorporate an overall metal shield.
* Provide an integral mechanism for achieving shield continuity between the connector and cable.

Modular Jack pinning and Color(s) shall be as identified in the above article “HORIZONTAL PERMANENT LINK”.

Coax Connector

Terminate coax cable at the Workstation and at the Telecommunications Rooms in a Male "F" type connector.

The Male F-Connector shall:

Be matched to the cable type proposed by the Contractor.

Be a single piece connector.

Incorporate a compression sleeve.

Incorporate seals to inhibit moisture from entering the connector assembly.

When preparing the cable for termination, manufacturer installation procedures shall be adhered to. Special care shall be taken to ensure the proper center conductor length as specified by the manufacturer.

Mate Male F Connectors to Female/Female Feed-thru Couplings at both the Outlet and Patch Panel locations. Match couplings to the Male F connector type. Couplings shall be of sufficient length as to allow for the Male F-Connector to fully seat (both sides).

Ensure that the proposed design considers the available mounting depth in both the existing wall boxes and possible Surface Raceway. This may include the provision of Right-Angle Plugs, Feed-through Couplings or other means.

Modular Plug

Where identified for 4-pair cable termination at a communications or security device, Modular Plug shall:

Support termination of solid copper conductors of the AWG specific to the cable type specified.

Meet the performance limits for the cable type specified as identified in the above article “HORIZONTAL PERMANENT LINK”.

Incorporate an overall shield when used to termination F/UTP cable type.

Incorporate gold plated contacts.

Provide for cable retention means other than the crimped conductors.

Be a snag-less design.

Retain conductors by means other than crimp on cable.

Incorporate strain-relief. A boot is optional.

The following section can also be used for Voice Patch Panels, with appropriate editing, if the end user requires them. If multiple applications (e.g., voice, data, CCTV) are all to use modular patch panels, confirm site requirements for keeping the panels separate or combining all cabling regardless of intended application.

Modular Patch Panel

Patch Panels shall incorporate Modular Jacks meeting the specifications for the Equipment Outlet detailed in the above article “EQUIPMENT OUTLET”.

Where patch panel is to incorporate jacks of a specified color to meet agency requirements, edit to provide the needed direction. This will typically require a patch panel design which incorporates individual jack positioning in a frame.

Jack colors should match those used at the Equipment Outlet.

Modular Patch Panel shall be [rack-mounted] [wall-mounted].

Rack –mounted panel shall be [Flat] [Angled].

Include the following (2) bulleted items where wall-mounted patch panels are specified. Otherwise, delete. For UW-Madison campus projects, there is an agency preference for wall-mounted 110/Modular panels on which backbone cabling is terminated at the horizontal cross-connect. (Example is SIEMON S110® MODULAR JACK BLOCKS). Confirm agency requirements and edit article as applicable. Where this product type is used, remove reference to protective cover plate.

Wall-mounted panels (if applicable):

* Cable interface shall be on the front of the panel (same size as modular jacks) [and be protected by a cover plate when in use].
* Shall incorporate a standoff bracket to allow for cabling to be routed behind the panel.

DFD recommends a maximum of two rows of 24 ports each (total 48 ports) being supported above or below with a horizontal cable management system. High-density panels including up to 72 ports between jumper management panels are allowed only where forced by mounting space limitations. Such high-density patch panel configurations must incorporate horizontal cable management systems sized to accommodate the quantity of patch panel jacks being installed. Where Angled Patch Panels are used, horizontal cable management between panels may be omitted and fewer, larger troughs included.

Modular Patch Panel configuration shall not exceed 48 ports (2 rows of 24 ports each) in a 2 RU panel.

Panel designs which feature removable modular jack assemblies may be partially populated. (See PART 3).

Modular Patch Panel cable termination shall:

* Have the ability to seat and cut 8 conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors.
* Be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
* Include color coded designation strips or other markings to identify conductor position.

Modular Patch Panels shall incorporate cable support and/or strain relief mechanisms to secure cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

Modular Patch Panel performance shall be as required to meet the specified Permanent Link and Channel performance.

Panels on which F/UTP cable is terminated shall incorporate:

* Ground clip(s) or spade(s) to achieve continuity between the connector shield and cable shield.
* Ground lugs (2).

Horizontal Jumper Management

Consider larger horizontal management where Angled Patch Panels are used. Edit content and drawings. Confer with Agency and DFD Engineer as applicable.

Equipment Rack shall be equipped with Horizontal Jumper Management Hardware as to allow an orderly routing of twisted pair, optical fiber and coaxial jumpers from the patch panels to the customer provided network equipment.

Horizontal Jumper management hardware shall be:

A 2 RU (3.5”), plastic or painted steel panel.

Configured with plastic “fingers” or a minimum of five (5) Jumper distribution rings (1.75" x 3.75" minimum dimension).

[Configured with a cover.]

Termination Blocks

General

Retain references to the Horizontal Cabling if that cabling is to be terminated on 110-type blocks. Otherwise delete those references.

Blocks shall be 110-type.

The mechanical termination shall:

Have the ability of terminating 22 - 26 AWG plastic insulated, solid and stranded copper conductors.

Provide a direct connection between the cable and jumper wires.

Each row shall be capable of terminating:

Six (6) 4-pair (Horizontal) cables using 4-pair Termination Clips.

Twenty-five pair groups (Backbone Cables) using 5-pair Termination Clips.

Block performance shall be as follows:

Horizontal Cabling: Category 6

Backbone Cabling: Category 3 performance or better.

Blocks shall incorporate a label holder which is to be used to identify the cable pairs. Label shall be color coded to indicate cabling type. Refer to specification Section 27 05 53 - Identification for Communications Systems for Label color and marking requirements.

Blocks shall identify pair position by a color designation - Blue, Orange, Green, Brown and Slate (Backbone only).

Fiber Optic termination Enclosure

This section is written for inter- and intra-building backbone fiber optic cables. Inclusion of fiber optic cable as part of the horizontal media (e.g., fiber-to-the-desk) is unusual for DFD projects. Specifications are available upon request from the DFD.

Fiber Optic Connector

Specify connector based on Agency standards. Where none exist, SC-type is DFD standard. LC-type is also acceptable. Use ST only in legacy installations if required to match Agency standards. Contact DFD for content for that connector type.

The Optical Connector shall be [LC] [SC]-type.

The connector ferrule shall be ceramic or glass-in-ceramic. The optical fiber within the connector ferrule shall be secured with an adhesive to prevent pistoning and other movement of the fiber strand.

The use of connector designs that feature a pre-cleaved fiber stub and factory polished connector assembly are acceptable for termination of Intra-building (ISP) backbone cabling on DFD projects. Acceptable means for mating the cabled fiber with the fiber stub include mechanical and fusion splice methods. Some agencies require use of factory-prepared cable assemblies on all fiber optic cabling. Confirm requirements with agency.

Cable termination method(s) shall be as follows:

* Inter-building (OSP) Backbone- Fusion splicing of factory-terminated cable assemblies (e.g., “pigtails”) to the installed cable.
* Intra-building (ISP) Backbone – [Use of factory polished connector assemblies which incorporate a pre-cleaved fiber stub to which the installed fibers are mechanically mated] [Fusion splicing of factory-terminated cable assemblies (e.g., “pigtails”) to the installed cable].

The Connector Body shall be a Composite material.

The attenuation per mated pair shall not exceed the following values:

Multimode 0.75 dB

Single-mode 0.75 dB

Mated pair attenuation shall include in-connector stub splice or splice used to splice pigtail to backbone cable.

These values shall hold throughout the Cable System. Connectors shall sustain a minimum of 200 mating cycles per EIA/TIA-455-21 without violating specifications.

The connector shall meet the mechanical performance criteria of the applicable EIA/TIA-455 Fiber Optic Test Procedures (FOTP).

UPC end-face finish is typical for single-mode connectors. Specify APC where required – typically on only a small portion of the total fiber count. Confer with Agency and DFD Engineer to determine such requirements.

Connector End-Face finish:

Multimode Physical Contact (PC)

Single-mode Ultra Physical Contact; UPC [and Angled Physical Contact; APC]

Color of Connector Body or strain-relief boot of Connector shall indicate fiber type as follows:

Multimode (62.5-micron) OM1 – Beige

Multimode (50-micron; LASER-optimized) OM3 – Aqua

Single-mode (UPC) – Blue

Single-mode (APC) – Green

Reflectance (max) when mated with a patch-cord made up of connectors of comparable design:

Multimode -20 dB

Single-mode (UPC) -40 dB

Single-mode (APC) -65 dB

Enclosure and Adapter Panels

All terminated fibers shall be mated to [Duplex SC] [Duplex LC] [ST] Adapters. Adapters shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types.

Where High-density panels (e.g., 24-fibers per panel) are thought to be required, confirm justification with DFD.

Each Adapter Panel shall support a maximum of 12-fibers (six duplex adapters).

Color of Adapter shall indicate fiber type as follows. (Not all may apply.)

Multimode (62.5-micron) OM1 – Beige

Multimode (50-micron; LASER-optimized) OM3 – Aqua

Single-mode (UPC) – Blue

Single-mode (APC) – Green

Edit for unique conditions where wall-mounted panels are required.

Fiber Optic Patch Panels shall be rack-mounted.

Fiber Optic Patch Panel enclosure shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings - including those not terminated (if applicable).

Unit height shall be 2 RU minimum to simplify access.

Fiber Optic Patch Panel shall be enclosed assemblies affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to protect the connector couplings and fiber optic jumpers.

Include locks only upon Agency request.

[Unit shall be lockable.]

The patch panel enclosure shall provide for strain relief of incoming cables and shall incorporate radius control mechanisms to limit bending of the fiber to the manufacturer’s recommended minimums or 1.2”, whichever is larger.

Access to the inside of the patch panel enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the cabinet to gain entry will not be accepted.

All Fiber Optic Patch Panels shall provide protection to both the “facilities” and “user” side of the coupling. The patch panel enclosure shall be configured to require front access only when patching. The incoming cables (e.g., Backbone, Riser, etc.) shall not be accessible from the patching area of the panel. The enclosure shall provide a physical barrier to access of such cables.

Where termination is to include splicing of factory-terminated cable assemblies, Patch Panel enclosure shall be sized adequately to accommodate the required splice hardware and fiber slack. Alternately, a separate enclosure may be used. The splice hardware shall not be accessible from the "user" side of the enclosure. Refer to Part 3 article “Splicing Procedure – Fiber Optic” for installation and performance requirements.

Confirm plan for use of innerduct with Agency and DFD.

“Traditional” plastic innerduct and Flexible Textile (Fabric) Innerduct are acceptable, and sometimes preferred, on DFD projects. Confirm product plan with DFD.

Flexible FABRIC AND Nonmetallic Innerduct and Fittings

General

Innerduct may be used as follows:

* To segment conduit(s), increasing their capacity,
* As protection to backbone fiber optic cables where otherwise installed unenclosed, and/or
* As protection to fiber optic cable(s) within equipment rooms and Telecommunications Rooms.

Equip all vacant innerduct with a pull cord

Non-metallic plastic Innerduct

This innerduct type shall be corrugated.

Where not installed in a continuous length, innerduct segments should be spliced using couplings designed for that purpose.

Any vacant innerduct capped at ends to inhibit the entry of water and contaminants.

Nominal duct size shall be 1-inch (minimum).

Innerduct should be rated (e.g., Flame-retardant, Riser or Plenum) as required by the installation environment. Riser and Plenum innerduct shall be of a color contrasting to that of the “Standard” and Flame-retardant innerduct. The preferred colors are Orange (“Standard & Flame-retardant) and White (Riser and Plenum).

Flame-retardant Innerduct

Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all of the above General requirements plus:

Be fabricated of flame-retardant materials suitable for installation such environments, and

Meet or exceed all requirements for flame resistant duct as required by Bellcore TR-NWT-000356 (Section 4.33).

Riser-rated Innerduct

Innerduct installed within building riser shafts shall meet all of the above General requirements plus:

Be fabricated of flame-retardant materials suitable for installation such environments, and

Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770.154 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

Plenum-rated Innerduct

Innerduct installed within a plenum air-return shall meet all of the above General requirements plus:

Be fabricated of flame-retardant and smoke inhibiting materials suitable for installation in such environments, and

Meet or exceed all requirements for flame propagation and emissions as specified by test method UL-910 and referenced by the National Electrical Code (NEC) Section 770-154 for listed optical fiber raceways being installed in ducts, plenums and other areas for environmental air, and

Meet or exceed all requirements specified by the National Fire Protection Agency (NFPA) 90A and 262 for Plenum spaces. Testing for fire and smoke characteristics shall be per UL-910.

Fabric Innerduct

Flexible Fabric innerduct shall be suitable for the conduit (dimension) in which it is used.

Configuration:

* (3) cell.
* Dimension – [Edit to consider conduit dimension and total cell count.]

Features:

* Melting point >400 degrees F
* Resistant to ground chemicals and petroleum products.
* Pull tape (color-coded) pre-installed in all cells
* Lubricated cells
* [Detectable]

Basis of design: MaxCell Edge

Edit this Article to match project requirements. Delete content that is not applicable.

Spares and Miscellaneous Materials

Deliver per Division 1 - General Requirements, “Loose and Detachable Parts”.

Spares

Provide:

* Modular Jacks matching the type(s) provided–consider performance and color(s).
* Equipment Outlet Faceplate of the type(s) provided.
* 1000-foot box matching the Horizontal Cable type(s) provided. Consider performance and color(s). Box shall be new and unopened.

Base spare jack and faceplate quantity on the scope of the initial installation:

Installed Jacks Spare Jacks Spare Faceplates

Initial 100 (10) (3)

200 – 500 (10) additional (3) additional

Each additional 500 (10) additional (3) additional

Include where applicable. Otherwise, delete Article in its entirety.

Cords and Cross-Connect Wire

Refer to specification Section 27 16 19 - Communications Patch Cords, Station Cords, and Cross-connect Wire.

Include only for projects requiring Security Fasteners and edit as applicable. Otherwise, delete Article in its entirety.

Security Fastener Tools

Provide tools required to operate the specified tamper-proof (security) fasteners. These tools shall be new and unused.

Coordinate with Div. 26 to obtain Handhole Security Fastener Tool(s) for tamper resistant locking covers on in grade handholes and boxes identified in specification Section 26 05 33.

Quantity: Five (5) sets of each tool required

Deliver tools to owner’s representative prior to project closeout.

Provide Tool model number(s) to allow for ordering of additional sets.

1. EXECUTION

General

Refer to Project Drawings which indicate Equipment Outlet locations, major cable routes and termination location(s) within each building. Coordinate duct allocation with the Agency.

Furnish and install all cables, connectors, hardware and equipment as shown on drawings and as specified above.

It is the contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

Identifying and report to the DFD Construction Representative any existing damage to walls, flooring, tiles and furnishings in the work area prior to start of work. All damage to interior spaces caused by the installation of cable, raceway or other hardware must be repaired by the Contractor. Repairs must match preexisting color and finish of walls, floors and ceilings. Any contractor-damaged ceiling tiles are to be replaced by the contractor to match color, size, style and texture.

Where unacceptable conditions are found, bring this to the attention of the DFD Construction Representative immediately. A written resolution will follow to determine the appropriate action to be taken.

Project Design Intent is for cable fill in conduit for communications to not exceed 40% based on the maximum number of cables anticipated (initial requirement plus 25% growth) and a nominal assumed cable outside dimension of 0.25 inches”. Identify to the DFD Construction Rep. shared pathways that do not provide this capacity.

Beginning installation means contractor accepts existing conditions.

Should it be found by the Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications and drawings with the respect or regard to the quality, value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

Furnish, install, test and document all cables, termination components and support hardware unless noted otherwise.

Equipment Rack Layout

Position termination hardware between 18- and 72-inches above the finished floor unless otherwise directed on drawings.

Position Fiber Optic Termination Hardware above other hardware.

Layout equipment with Horizontal Management positioned at the top of the rack and adjacent to termination hardware as specified.

Salvage Materials

Include this Article where Removal/Recycling language in remodeling project where Div. 27 contractor is responsible for removal of abandoned cable. Otherwise, Delete in its entirety. Annotate drawings to indicate areas where cable and devices are to be removed.

Remove and recycle unused, undocumented and otherwise "abandoned" cables prior to the completion of the project.

The Agency shall be responsible for identifying and labeling all abandoned cable within the boundary of this project.

“Abandoned Cable” is defined per NEC 2011 Articles: 640, 645, 725, 760, 770, 800, 820 and 830. Further definition is contained in NFPA-75, NFPA-76 and NFPA-90A.

Disconnect abandoned Equipment Outlets and remove devices.

Remove cabling and communications devices in walls, floors, and ceilings scheduled for removal.

Provide blank cover for abandoned Equipment Outlet boxes that are not removed.

Schedule work with Owner/Agency and other contractors.

If salvaged materials are to be re-used or otherwise returned to the Owner, make sure the items to be removed from service and turned over to the Agency are identified on the drawings.

Except where noted on the project drawings, materials removed shall become the property of and shall be disposed/recycled by the Contractor.

Maintain materials and equipment to be turned over to the DFD/agency and/or reused in condition equal to that existing before work began. Repair or replace materials or equipment damaged by the Contractor at no additional cost to the State.

Cleaning and Inspection

Refer to specification Section 26 05 04 – Cleaning, Inspection and Testing of Electrical Equipment.

Backbone Cable System Topology and Cable Size Requirements

Work with Agency and refer to DFD Telecommunications Guidelines in determining the count of copper pair, and single-mode and multi-mode optical in the backbone cabling. It is DFD preference that this information be included on the project drawings.

Backbone Optical Fiber and Copper Pair counts in the cables to be supplied are detailed on the Project Drawings.

Prior to construction, verify pair count with the Engineer to confirm capacity of the backbone copper cabling to support the intended connectivity to the Horizontal Cabling.

Cable Installation

General

Install all cables in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

Cable shall be suitable for and meeting the Listing requirements of the installation environment through which it passes.

Furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but not limited to, sheaves, winches, cable reels, cable reel jacks, duct entrance tunnels, pulling tension gauge and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices, which may move or wear in a manner to pose a hazard to the cable, shall not be used.

Pull all cable by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to ensure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a “break-away” or other approved method.

Where recommended by the cable manufacturer, use a swivel between the pull-line and pulling grip to prevent the pull-line from imparting a twist to the cable.

Complete all work using qualified personnel utilizing state-of-the-art equipment and techniques. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit, as well as to feed cable and operate pulling machinery.

Pull cable in accordance with cable manufacturer’s recommendations and ANSI/IEEE C2 standards. Manufacturer’s recommendations shall be a part of the cable submittal. Recommended pulling tensions and pulling bending radius shall not be exceeded.

Install cable unenclosed, in a secured metal raceway, in cable tray or in modular furniture as designated on the plan drawings. All cable shall be free of tension at both ends.

Avoid abrasion and other damage to cables during installation.

Pulling Lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.

All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Mesh-type (e.g., “Kellem”) grips may be used to spread the strain over a longer length of cable.

Manufacturer’s minimum bend radius specifications shall be observed in all instances.

Within the equipment room in which cabling is terminated, use only Hook and Loop (e.g., “Velcro”) ties from room entry to the point of termination. This is to facilitate the addition of future cables.

A pull cord (nylon; 1/8” minimum) shall be co-installed with all cable installed in any conduit.

Protection of cable and devices from foreign materials:

Coordinate with other trades and provide adequate physical protection during construction to prevent foreign material application or contact with cables and devices.

Foreign material is defined as any material that would negatively impact the validity of the manufacturer’s performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

Overspray of paint on any cable, cable jacket, termination component or device will not be accepted.

Use of any cleaning agents to remove overspray shall be per the cable manufacturer’s written consent.

Replace any component or assembly affected by a foreign material. This shall be at no additional cost to the project.

Should the manufacturer and/or warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced.

In the case of plenum cabling, in addition to the statement from the manufacturer, submit a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

Inter-building Backbone Cable Installation

Where cabling transits a manhole, form cabling along the manhole wall (maintaining the necessary bend radius) and secure. Provide new support where required.

Fiber Optic Cable Installation

Provide cable slack in each Backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation.

Store cable slack in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose, in a loop secured to cable runway or wall. Multiple cables may share a common enclosure. Slack required in the various subsystems is as follows:

Backbone Inter-Building: A minimum of 5-meters (approx. 15-feet) of slack cable (each cable) shall be coiled and secured at both ends - preferably at the Entrance Room and/or Main Equipment Room.

Backbone Intra-Building: A minimum of 5-meters (approx. 15-feet) of slack cable (each cable) shall be coiled and secured at one (1) end - preferably at the Entrance Room and/or Main Equipment Room.

The preference for the use of innerduct is site-dependent. Confirm requirements with Agency and consult with DFD Engineer for guidance.

Backbone Fiber Optic Cable [shall] [shall not] be installed in protective innerduct. [This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g., between conduit & cable tray or into equipment racks).]

Splicing Procedure – Fiber Optic

Include only where project includes splicing of fiber optic cable. Otherwise delete in its entirety.

Size enclosure based on cable type(s), cable count and total fiber count. Counts shall not exceed maximums recommended by the splice closure manufacturer.

Provide adequate slack cable to allow for slicing operation to be performed in a protected area.

For cabling installed in underground ducts, this slack shall be adequate to perform the splice in a tent or vehicle positioned in an accessible area adjacent to the maintenance hole in which the splice is to be secured.

For cabling installed on an aerial route, this slack shall be adequate to perform the splice in a tent or vehicle positioned in an accessible area adjacent to utility pole closest to where the splice is to be secured.

Prepare Splice Enclosure and cables per manufacturers recommended procedures.

Configure splice as a “Butt” splice (all cables enter same end of closure).

Secure each cable central member and strength element(s) individually.

Bond metallic cable elements and make continuous through the splice. Bond to ground

Splice optical fibers using the fusion method. Individual splice loss shall not exceed:

0.3 dB for Multimode fibers

0.3 dB for Single-mode fibers

Secure and protect finished splices in Splice Tray(s) per splice closure and cable manufacturer’s recommendations.

Complete and seal splice enclosure.

Secure cable slack.

For cabling installed in underground ducts, coil cable slack in maintenance hole. Diameter of coil shall meet minimum cable bend radius requirements.

For cabling installed on an aerial route, run cable slack along messenger and use cable “Snowshoe” product per manufacturer’s recommendations.

Horizontal Cable Installation

Refer to the project Drawings which identify the location of the Horizontal Cross-connect and Equipment Outlet (EO) locations.

Route Horizontal Cabling on each Floor to the Telecommunications Room (TR) on that floor or to the designated TR if on another floor.

The maximum Horizontal Cable length shall not exceed 295-feet (90-meters). This length is measured from the termination in the wiring closet to the equipment outlet and must include any slack required for the installation and termination.

Route horizontal cabling in a fashion as to avoid unnecessarily long runs. Identify and report to the engineer prior to installation any area that cannot be reached within the above constraints.

Where installed unenclosed:

Route cable at right angles and clear of other trades work.

Support cables utilizing "J-Hook", “Bridle Ring” or similar supports anchored to ceiling concrete, or structural steel beams. Cable support devices shall be designed to maintain cables bend to larger than the minimum bend radius. J-Hooks shall incorporate a metal wire or other type closure to retain the cables. Bridle Rings shall be equipped with “saddles” to maintain the required bend radius.

Space supports at a maximum 4-foot interval unless limited by building construction. Cable "sag" at mid-span shall not exceed 6-inches. Place additional supports as required to clear other trades work.

Do not attach cables to or support cables using existing plumbing or steam piping, ductwork, raceways or cabling.

Route cable to allow removal of ceiling tiles. Do not place cable directly on the ceiling grid or attach cable in any manner to the ceiling grid wires.

Limit cable bundles (e.g., those secured with cable ties) to (24) or fewer cables in each bundle.

Cable routing shall not limit maintenance access to mechanical systems, piping (e.g., valves, takeoffs for future work), controls and other systems.

Take care in the use of cable ties to secure and anchor the horizontal cabling. Do not overtighten ties as to compress the cable jacket. No sharp burrs should remain where excess length of the cable tie has been cut.

Protect cable sheaths from damage from sharp edges. Where a cable passes over a sharp edge, provide a bushing or grommet to protect the cable.

At Equipment Outlet locations, provide slack in each horizontal cable under 250-feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support (e.g., J-Hook, Bridle Ring, etc.) before the cable leaves the ceiling. Minimum coil diameter shall be 8-inches. Secure coils with Hook & Loop cable ties.

Slack cable length shall–unless noted otherwise on the project drawings–be as follows:

* Where cables enter a fishable wall, conduit, surface raceway or box: 4-feet.
* Location where cables are installed into movable partition walls or modular furniture via a service pole: 15-feet.
* At Wireless Access Point (WAP) and Security Camera locations: 20-feet.

At all Telecommunication Rooms (TR), provide approximately 10-feet of slack in each horizontal cable to allow for changes in the telecommunication room layout without re-cabling.

This slack shall not be required where a horizontal cable length in excess of 295-feet would result.

Secure cable slack to the cable runway above the equipment racks.

Cable bend s shall be 200% of the cable recommended minimum bend radius or greater.

Minimum separation distances between communications wires and cables, and any electric light, power, Class 1, non-powered fire alarm, or medium power network-powered broadband communications circuit shall comply with NEC Article 800.

In addition, to reduce or eliminate EMI, the following minimum separation distances shall be adhered to:

Thirty-nine (39) inches from transformers and motors.

Cabling installed unenclosed or in cable tray shall be separated from fluorescent lamps and associated fixtures by a minimum of 5 inches (125 mm).

Zero pathway separation distance is permitted when electrically conductive communications cables, power conductors or both are enclosed in metallic pathways that meet the following conditions:

* Metallic pathway(s) completely enclose the power conductors and are continuous;
* Metallic pathway(s) are properly bonded and grounded per ANSI/TIA-607-B; and
* Walls of the pathway(s) have a minimum thickness 1 mm (0.04 in) nominal if made of steel (1/2” EMT minimum)

No separation is required between power and communications cables crossing at right angles. The cables shall not, however, be supported by the power cabling.

Sleeve all openings and fire-stop per prevailing code and building construction ratings upon completion of cable installation.

Horizontal Cabling in Modular Furniture

Coordinate this section with the plan drawings. Coordinate location, number and size of pathways (poke-thru fitting, box, etc.) with furniture plan and intended cable quantities. Pathway design shall consider fill ratios, bend limits on the Category 5e/6 UTP and the eventual feed into the furniture partition.

Protect cabling routed from an in-wall box, poke-through fitting or other device to modular furniture without wall contact via a length of flexible plastic conduit, “spiral wrap” or other approved protective means. Conduit fittings shall be compatible with the "Poke-thru" and Wall Fittings proposed. There shall be no exposed cable in the transition to the modular furniture. Fill Ratio (Cable Area vs. Conduit Area) in each feed shall not exceed 40%.

Where horizontal cabling is routed to a floor fitting via the floor below, the cabling shall return to the floor on which the Equipment Outlet appears and be terminated in the Telecommunications Room serving other Equipment Outlets in that area.

For purposes of bidding, assume that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.

For purposes of bidding, assume that it will be the responsibility of the Contractor to punch and re-install the bottom molding panels on the modular furniture as required to accommodate the Communications cabling and Equipment Outlets. The panels shall be marked prior to installation by the owner to identify the desired location of the Equipment Outlets Bring to the attention of the DFD Construction Representative any discrepancy between the Project Drawing identifying Outlet locations and the markings.

Secure the EO to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the EO to the panel shall not result in sharp protrusions (e.g., sheet metal screw tip) into the channel behind the panel.

Grounding

Where a cable incorporates metal armor, strength elements, shielding or other metallic elements (not including conductors), Bond those elements to an approved ground using a #6 AWG solid copper conductor. Cable grounding hardware and method shall be per manufacturer’s recommendations.

Confer with DFD as to acceptability of the following. Interrupting metallic elements or use of an insulating joint is not advised when the cable enters the building in an Equipment Room.

*Exception*: Non-current-carrying metallic members of a Fiber Optic Cable may, as an alternative to grounding, be interrupted by an insulating joint or equivalent device.

The grounding [or interruption] shall be as close as practicable to the point of entrance.

Equipment Outlet

General

Mount outlets flush in wall-, ceiling- and/or ceiling mounted boxes, in floor boxes and/or poke-through assemblies, on Surface Raceway and in modular furniture. Refer to project drawings for applicable outlet types.

Mount level.

Unless noted otherwise on drawings, default mounting height (from finished floor to center line of outlet) in new installation shall be as follows:

Standard Equipment Outlet 18-inches

Outlet for Wall-Mounted Telephone per ADA

Assemble and terminate connectors per manufacturer’s recommendations.

In shielded installations, assemble to ensure continuity between connector shield and cable shield.

Fit all Connectors (e.g., modular jacks and coaxial type) with a dust cover. If the modular jack design requires an integral dust cover, ensure that the covers are securely seated.

Include the following if Security Fasteners are required. Otherwise, delete.

Secure Equipment Outlet faceplate using tamper-proof (security) fasteners. Confirm fastener type with agency prior to construction.

Wireless Access Point (WAP) Locations

Unless noted otherwise on drawings, mount Equipment Outlet intended for use with a Wireless Access Point (WAP) as follows:

Drop Ceilings - Cut ceiling tiles and deliver cabling into 4-11/16” square, deep outlet box mounted on a grid box hanger (a.k.a. “tile bridge”).

Exposed Ceilings (surface mount) - cabling piped to a 4-11/16” square, deep outlet box. Unless mounted to structure, support outlet box using threaded rod or other means. Mount so assembly is horizontal.

Reduce 2-gang or larger openings to 1-gang using “mud ring”.

Equipment Outlet locations for Wireless Access Points as shown on drawings are approximate. Coordinate final locations with Agency.

Elevator Control Room

Coordinate with agency to confirm any site-specific preferences for configuration of Equipment Outlet(s) for Communications and Electronic Security at Elevator Control Room. Provide direction on drawings.

Provide Horizontal Cabling for each in-Cab Telephone and Electronic Security Device per project drawings.

Coordinate with Division 14 to confirm configuration of the Equipment Outlet(s) for Communications and Electronic Security at Elevator Control Room.

Innerduct

Confirm/Edit drawing content to ensure clear direction is given as to where protective innerduct is required.

Refer to the Project Drawings which identify the use of protective innerduct.

Innerduct shall be Listed as Riser- or Plenum-type as required by the installation environment.

Where not installed in a continuous length, splice innerduct segments using couplings designed for that purpose.

Label exposed innerduct at 35-foot (minimum) intervals with tags indicating cable type (e.g., "Fiber Optic Cable") and the cables it contains.

Contractor shall determine optimum size and quantity to satisfy the requirements of the installation ensure that the mechanical limitations - including Minimum Bend Radius - of the cable are considered.

Where protective innerduct is used in an Equipment Room, extend innerduct to the termination enclosure.

Refer to manufacturer’s recommendations for installation of Fabric Innerduct.

* Installation of fabric innerduct concurrent with cable installation on a conduit is acceptable.
* Swivels must always be used.
* Factory installed pull tape must free-float during installation.

Cable Termination

General

At the Telecommunications Rooms, position all Data and Voice Cables on termination hardware in sequence of the Outlet I.D. starting with the lowest number.

Termination Hardware (Blocks and Patch Panels) Positioning and Layout must be reviewed and approved by the Engineer prior to construction. The review does not exempt the Contractor from meeting any of the requirements stated in this document.

At each Equipment Outlet (or communications or security device where cable is terminated in a Modular Plug), terminate cabling per manufacturer’s recommendations and as identified in the above article “HORIZONTAL PERMANENT LINK”.

Where F/UTP cabling is installed, maintain continuity of the shield from Modular Patch Panel to EO or Modular Plug.

Edit to remove references to unused block types where there is no distinction between horizontal cable designated for “Voice” or “Data”. Edit to confirm mounting of blocks on which Backbone cabling is terminated (e.g., if on equipment rack).

Cable Termination –Blocks

General

Refer to the Project Drawings which indicate mounting requirements for Termination Blocks.

Coordinate the placement of blocks with other cabling where applicable.

Provide spare capacity–unless otherwise noted on project drawings–as follows:

Provide Horizontal Blocks to accommodate minimum of 20% growth in the quantity of equipment outlets relative to the initial installation, adjusted upward to the nearest commercially available block size.

Provide Intra-building (ISP) Backbone Blocks to accommodate minimum 20% growth, adjusted upward to the nearest commercially available block size. Assume (1) that all four pairs in horizontal cabling designated as for “Voice” are cross-connected to the backbone cabling.

Size Blocks for Inter-building (OSP) Copper Backbone Cabling to include 30% growth relative to initial requirements, adjusted upward to the nearest commercially available block size.

Provide cable management hardware (e.g., D Rings and cable guides) to neatly and securely route cabling to the blocks.

Where wall-mounted blocks are specified:

Mount on a prepared surface (e.g., 3/4-inch plywood) securely fastened to the building walls. Plywood shall be fire-retardant type or be painted with fire retardant paint. Refer to plan drawings.

Provide Horizontal Troughs incorporating plastic or metal distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block.

Provide metal or plastic split distributing rings on both sides of the column of blocks to accommodate vertical routing of jumpers.

Where Horizontal and Backbone Cabling blocks are oriented vertically (rather than side-by-side), provide a backboard incorporating plastic distribution rings allowing for a change in direction in cross-connect wiring between the blocks of each type.

The Height of the Voice Termination Field shall not exceed 6-feet (72-inches) above floor level to facilitate cable maintenance.

Position Blocks on which Backbone and Horizontal Cabling are terminated in separate columns. Position Backbone Cabling to the Left; Horizontal Cabling to the Right. Position Blocks close proximity to simplify installation and subsequent tracing of cross-connect wiring. Where new cabling is to be integrated with existing cabling at the building entrance, it will be the responsibility of the Contractor, in cooperation with the Owner, to coordinate placement of Voice Termination hardware with the Local Exchange Carrier(s) serving the site.

Route cables to wall-mounted blocks from below the blocks in a manner that will facilitate growth.

Cable Management

Provide Horizontal Troughs incorporating split plastic distribution rings to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block.

Position Rings between the Backbone and Horizontal Cabling Blocks for vertical routing of jumpers and/or cross-connect wiring.

Termination

For termination of Horizontal Cabling, use four-pair (e.g., C4-type) clips. The twenty-fifth pair of each row on the 110-type block located at the Horizontal Cross-connect (e.g., Telecom Room / IDF) shall not be used for termination of horizontal voice cable.

For termination of Backbone Cabling, use five-pair (e.g., C5-type) clips.

Ensure that the twists in each cable pair are preserved to within 1.0-inch of the termination for all Voice UTP backbone cables and within 0.5-inch for Category 5e and Category 6 cables. Remove cable jacket only to the extent required to make the termination.

Voice Multiplier Block

This feature allows for multiple appearances of a single telephone line. The Agency can wire from this common point to as many cable terminations as required.

At the Main Cross-connect location (MDF), provide (1) Voice "Multiplier Block" to accommodate the potential for multiple extensions of a single line.

Multiplier Block shall be formed by running short sections of Cross-connect wire vertically through each index strip on a 100 pair block (4 rows). Five (5) Pair connecting clips shall be used.

Block application and the common connections shall be clearly marked on the designation strips.

Cable Termination - Modular Patch Panels

Install Modular Patch Panel(s) in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.

Size Modular Patch Panels to accommodate a minimum of 20% growth in the quantity of equipment outlets relative to the initial installation.

Panel designs which feature removable modular jack assemblies may be partially populated.

Include the following for UW Madison-campus. Otherwise Delete.

All jack positions in a row shall be populated.

Various systems might use twisted-pair cabling terminated in a Modular Patch Panel. These include Telecom, Network (wired), WiFi (Wireless Access Points), Security Cameras, others(?). Edit this article and/or Drawings to direct as to how cabling for these systems is to be organized and identified (numbering). Separate panels and/or numbering sequences is not uncommon. Select one of the two following options to match Agency requirements and edit to clarify intent.

Cables designated for various systems (e.g., Network, WiFi, Security) shall be terminated on [shared] [separate] patch panels.

At Equipment Outlet and Modular Patch Panel, ensure that the twists in each horizontal cable pair are preserved per manufacturer’s recommendations, typically to within 0.5-inch of the termination. Remove the cable jacket only to the extent required to make the termination.

Bond F/UTP cable shield and drain wire to connecting hardware per manufacturer’s instructions. Bond connecting hardware to the Telecommunications grounding system.

Provide horizontal cable management hardware above and below each Modular Patch Panel.

*Exception*: Where angled patch panels are specified, provide horizontal management above and below patching area. In large installations, add management in the middle of the patching area. Refer to project drawings.

Cable Termination - Fiber Optic

In rare circumstances, un-terminated optical fiber will be allowed. This must be approved by the DFD Engineer and DFD Project Manager.

Provide Fiber Optic Patch Panels configured with connector adapters (couplings) adequate to accommodate the number of fibers to be terminated.

Terminate optical fibers using the specified connector type.

Mate terminated fibers to couplings mounted on patch panels. Adapters shall be mounted on a panel that, in turn, snaps into the housing assembly.

Fit any unused panel positions with a blank panel which blocks access to the fiber optic cable from the front of the housing.

Provide and organize couplers as follows:

Fibers from multiple locations may share a common enclosure. They must, however, be segregated on the connector panels and clearly identified.

Connectors from different location shall never share a common coupling panel.

Segregate single mode and multi-mode (where applicable) optical fibers on the panels as to clearly identify the distinction between the fiber types.

Install Duplex Adapters 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-568 (referenced version). Refer to that standard for further detail.

Note: Factory screening of adapter panels sometimes complicates adapter panel layout. Confirm plan with engineer prior to construction.

Position optical fibers consecutively and mapped "position for position" between patch panels. There shall be no transpositions in the cabling. “Reverse-pair positioning” is not allowed.

Fit all couplings with a dust cap.

Provide slack in each fiber as to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30” high workbench positioned adjacent to the termination enclosure(s). A minimum of 1-meter (~39”) of slack shall be retained regardless of panel position relative to the potential work area.

Where "Loose Buffered" cables are installed, use a manufactured "fan-out" kit whereby individual fibers are secured in a protective covering which extends from the buffer tube to the connector assembly.

Clean all fibers once mated to adapters and protect with dust cap. Follow manufacturer’s recommendations for cleaning technique and products.

Where fibers are to be left unterminated, prep all such fibers in a fashion as to facilitate future termination. Splice Tray. Label Blank Panels intended for initially unterminated fibers as “Future” and indicate fiber count.

Cable Termination - Coax

Prepare cable for termination per manufacturer’s installation procedures. Special care shall be taken to ensure the proper center conductor length as specified by the manufacturer.

Terminate all cables in the specified connector type.

At the Horizontal Cross-connect, [mate with F-type feed-through couplings mounted on rack-mounted patch panel][coil and secure terminated cable. Provide adequate slack for cables to reach planned location for distribution hardware.]

At the Main Cross-connect, [mate with F-type feed-through couplings mounted on rack-mounted patch panel][coil and secure terminated cable. Provide adequate slack for cables to reach planned location for distribution hardware.]

Size Patch Panels (if applicable) to accommodate 20% growth in the number of cables terminated.

Cross-connect Wiring and Patching

It is increasingly rare that the Contractor is responsible for the Horizontal-to-Backbone cross-connect. Edit article to match project requirements.

General

The [Contractor][Agency] shall be responsible for the “Cross-connect” wiring or Patching between Horizontal and Backbone cabling.

The Agency shall be responsible for cross-connects between the cabling terminations at the Main Cross-connect (e.g., Entrance Room, Main Equipment Room, MDF) and Inter-building Backbone or Internet/Telephone Service Provider cabling. It shall be the responsibility of the Contractor, to work with the Agency and DFD Construction Representative and provide the necessary assistance to allow Agency and/or service provider personnel to make the necessary connections to establish service on the new cable system. Provide cross-connect documentation, general wiring overview and cable pair identification as required to support this work.

Select the applicable content below – either Cross-connect Wiring or Patching – and delete non-applicable content. Delete both if agency is to be responsible for all cross-connect wiring and/or patching.

Cross-connect Wiring

Where horizontal cabling designated for “Voice” applications is terminated in Blocks, install cross-connect per agency direction.

Do not fasten cables directly to support brackets with wire or plastic ties. Neatly lace, dress and support all cabling. Provide Retainer Clips on each 110-type block to secure jumper wires on the wiring block(s).

Patching

Where all horizontal cabling is terminated in Modular Patch Panel, complete patching between those panels and backbone cable termination hardware per agency direction. Perform patching using cords appropriate for the cable system configuration and backbone cable termination hardware type (blocks or modular panels).

Identification and Labeling

Make sure that Section 27 05 53 is included and edited to include required formats.

Refer to Section 27 05 53 “Identification for Communications Systems” for Identification and Labeling guidelines for this Project.

Label all Backbone and Horizontal Cable, Outlet Faceplates, and Termination components (e.g., Voice Termination Blocks & Modular Patch Panel).

Prior to installation, provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used.

Testing and Acceptance

General

Prior to testing, provide a Test Plan for each cable type including equipment (makes/models) to be used, set-up, pass/fail limits and results format. A sketch of each test set-up (hand-drawn is OK) and results report examples are encouraged.

The Test Plan shall consider the requirements identified below plus any manufacturer-required test, test method or reporting format needed to support the specified warranties.

Test results format should include proposed filenames and be organized by Cable Type, Subsystem (Horizontal or Backbone), Building and Equipment Room. Prefix filenames with the DFD project number.

Content of native format records should be organized to allow for interim records to be combined into the composite results package required at project closeout.

Failure to provide the above information shall be grounds for the Engineer and/or DFD to reject any and all Documentation of Results on related testing and to require a repeat of the affected test(s).

Visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. Provide to the Engineer with a written certification that this inspection has been made.

Conduct acceptance testing according to a schedule coordinated with the Agency and DFD.

Agency and DFD representatives may be in attendance to witness the test procedures. Provide a minimum of one (1) week advance notice to allow for such participation.

Provide Test Plan as part of this notice or sooner.

Supply all equipment and personnel necessary to conduct the acceptance tests.

Test equipment and measurement methods shall comply with the standards referenced in PART 1.

All equipment used in testing shall be maintained and calibrated per manufacturer’s guidelines. Provide documentation of equipment calibration.

Set Test Unit Limits to match specified performance requirements. For example, for Category 6 Horizontal Cabling, limits should be set to “Category 6 Permanent Link”. Test limit for fiber optic cable should be set to consider cable length, connectors and, if applicable, splices as detailed in PART 2 and below.

Perform tests related to connected equipment by others only with the permission and presence of the agency and/or responsible contractor.

The Engineer or DFD may request that a random field re-test–not to exceed 10% of the installed cabling–be conducted on the cable system to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. Any and all re-tests shall be at no additional cost to the project.

All cabling shall be 100% fault free. Should it be determined by the Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications and drawings with regard to quality, performance, value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes in consequence of said defects or imperfections made good at the Contractor expense.

Where the installation includes use of existing or agency-provided cabling and/or connectivity components, links that fail to meet the specified limits (e.g., Category 6) shall be evaluated by the contractor to determine the likely cause of the failure. Contractor shall propose a plan for corrective action to the DFD Construction Representative and Engineer for approval prior to any rework and/or cable or component replacement. Such corrective actions and related re-tests will be considered additions to contractor scope.

See Article DOCUMENTATION for required results report formats.

Copper Backbone Cabling

Verify cable as free of shorts within the pairs, for continuity, pair validity and polarity and for conductor position on termination hardware.

For pair counts exceeding 100-pair, a percentage of “bad” pairs not to exceed 3% in any cable shall be allowed. Identify and document all bad pairs.

Correct any mis-positioned pairs.

Horizontal 4-pair Copper Cabling

General

Test from the Equipment Outlet to the Modular Patch Panel (or Wiring Block) at the TR on which the cables are terminated.

Cables shall be installed and dressed at the patch panel and secured in the outlet box at the Equipment Outlet location with the faceplate in place.

The cabling must pass all the specified requirements. Conditional passing test results that are within the measurements accuracy of the test equipment (e.g., “\*PASS”) are not acceptable.

When the EO is located on/in the wall behind modular furniture, a patch cord may be inserted into the EO to allow the furniture to be returned to its normal location. Cable testing, in this case, will be done with the patch cord. If the cable test fails only due to the length of the patch cord, the DFD will accept the cable as passing. Provide list of such locations in Test Results documentation.

Horizontal cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and Wire Map (Conductor Position on the Modular Jack).

Correct any defective, split or mis-positioned pairs.

Test Cable Systems rated at TIA Category 5e and higher to include Performance Testing as detailed in the following article.

Performance Testing

Test Performance per ANSI/TIA-568-C.2 Permanent Link test configuration and procedures.

Test using a test instrument designed for use with the installed cable type(s) and specified standards. The instrument shall verify “PASS” on each cable and record the results of all tests, comparing measured values with standards-based limits.

Test Transmission Performance of Horizontal Cabling to include the following:

Length

Attenuation (Insertion Loss)

Pair-to-Pair NEXT Loss

PSNEXT Loss

Attenuation-to-Crosstalk Ratio (ACR)

Power-sum ACR (PSACR)

Propagation Delay

Delay Skew

Return Loss

DC Loop Resistance

ANSI/TIA-1152 Optional++ Tests including:

 Transverse Conversion Loss (TCL)

 Equal Level Transverse Conversion Transfer Loss (ELTCTL)

 DC Resistance Imbalance (in-pair & pair-to-pair)

The maximum length of horizontal cable Permanent Link shall not exceed 90 meters (295 feet).

Program test unit to match Net Propagation Velocity (NPV) of the installed cable type.

In the event results of the tests are not satisfactory, make changes as necessary and repeat the test or tests which disclosed faulty or defective material, equipment or installation method.

Special Considerations

Where Cabling is terminated in a Modular Plug at the device location (e.g., Video Surveillance Camera or Wireless Access Point), test per standards for a Modular Plug Terminated Link (MPTL)..

Where the horizontal cabling includes an interconnect (e.g., where a zone cable is extended from a Consolidation Point to the work area Equipment Outlet (EO)), testing of the Permanent Link shall be from the Horizontal Cross-connect at the Telecom Room to the EO and include the interconnect.

Where a Surge Protector is in place as part of the Horizontal Permanent Link, performance testing shall include the Surge Protector as part of the link.

Where F/UTP cabling is installed, testing shall include Shield Continuity.

Voice Channel Test

Where cross-connection of Horizontal & Backbone cable is contractor responsibility:

Test each subsystem separately.

Test the completed “Channel” after cross-connect wiring/patching is complete.

Voice Channel Test confirms the end-to-end voice transmission between the Main Cross-connect and the Equipment Outlet (Voice).

Test all pairs to be free of shorts and verify for continuity, pair validity, polarity, and conductor position.

Correct any mis-positioned pairs or cross-connect wiring. Replace any patch cords/jumper cables which cause the Voice Channel test to fail and retest Channel.

Performance testing on the Voice Channel is not required.

Fiber Optic Cable

General

The fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, provide cable manufacturer’s test report for each reel of cable provided. These test reports shall include:

1. Manufacturer’s on the reel attenuation test results at the specified wavelengths for each optical fiber of each reel prior to shipment from the manufacturer.
2. On-the-reel Bandwidth performance as tested at the factory.

Tests Prior to Installation

At Contractor discretion and at no additional cost to the project, contractor may perform tests s/he considers necessary to ensure integrity of any cable to be installed. Upon request, supply this test data to the Engineer prior to installation.

Tests After Installation

Upon completion of cable installation and termination, test Fiber Optic cabling to include:

1. Optical Attenuation
2. Verification of Link Integrity and component losses

For projects at University of Wisconsin – Milwaukee, include the following:

1. Connector End-face Condition per IEC 61300-3-35 (inter-building backbone cabling only)

Optical Attenuation Testing

Measure end-to-end Optical Attenuation on all terminated optical fibers in at least one direction of transmission. Measurement shall be inclusive of the optical fiber, and optical connectors and couplings installed at the system endpoints.

Test using one of the following methods:

Insertion Loss method using an Optical Loss Test Set (OLTS) or an OTDR which integrates an Attenuation Measurement function.

OTDR method must record the combined loss of the optical fiber and connectors at both ends of the link. Configure OTDR set-up to match project specifications.

Where Insertion Loss method is used:

Test multimode fibers in accordance with TIA-568 and -526-14 (Method B; one jumper reference) at 850 and 1310 nm (nominal).

Test single-mode fibers in accordance with TIA-568 and -526-7 (Method A.1; one jumper reference) at 1310 nm (nominal) and 1550 nm.

Attenuation (end-to-end) shall not exceed the values calculated as follows:

Multimode fiber where cable length ≤ 300-meters and includes no splices – 2.5 dB

Single-mode fiber where cable length ≤ 300-meters and includes no splices – 1.8 dB

Cable > 300-meters or any cable containing splices – 2\*C+(L\*F)+S

Where:

C = maximum allowable Connector Loss

L = length of the run

F = maximum allowable fiber loss per unit length (e.g., dB/kf.

S = total splice loss (# of splices \* max. attenuation per splice; Do not count the “pigtail” splice.).

Where an OTDR is used to measure attenuation, use of the bi-directional test (average) is acceptable.

OTDR Testing

Consult with the DFD to confirm testing and documentation requirements where termination of less than all installed fibers is allowed.

Document all fibers – even those that are left un-terminated (if applicable) – in both directions of transmission using an Optical Time Domain Reflectometer (OTDR).

Test multimode fibers at 850 and 1310 nm (nominal).

Test single-mode fibers at 1310 nm (nominal) and 1550 nm.

OTDR(s) used in testing shall incorporate high-resolution optics optimized for viewing of short cable sections. Set Pulse Width to shortest width usable and still obtain clean trace.

Use jumpers of adequate length at both ends of cable under test to allow viewing and accurate measurement of the entire link – including cable and connectors at the launch and tail end.

Configure Test Unit to match Refractive Index (as indicated on the product datasheet) for the fiber type under test.

OTDR traces revealing a point discontinuity greater than 0.2 dB in a multi-mode fiber, or 0.1 dB in a single mode fiber at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a basis for rejection of that fiber by the Owner. The installation of that cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that cable and the associated terminations shall be replaced at the expense of the contractor.

Submitted traces should document connector Reflectance performance as meeting the specified criteria for the connector type(s) installed.

Configure Test Unit Pass/Fail Threshold for Reflectance to match the specified value for the fiber type under test.

Coaxial Cable Testing

Test coaxial cables to:

Locate Breaks, Faults or flawed terminations.

Verify Length.

Verify Impedance (to within 5% of nominal value).

Verify Return Loss (5-MHz to 1-GHz).

Terminate cable – as required by individual tests – with its characteristic impedance.

Documentation

General

Provide project documentation as detailed in the sub-sections below.

Submit all documentation in electronic form.

Edit the following paragraph to include the paper copies required by the agency. DFD does not require paper copies of any documentation.

In addition, provide [(1)][(2)] paper copies of Record Drawings.

Where documentation provided in electronic form requires unique software (e.g., NATIVE formats) other than Adobe Acrobat Reader for viewing test results, provide one (1) copy of such software. The software shall run on Microsoft *Windows operating system*. Software shall include license if applicable.

Organize documentation by Building, Telecom Room and cable type.

Name file(s) and records to include building, route or other cable identifiers that match labeling formats used. Prefix file name with the DFD project number.

Provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Engineer, provide copies of the original test results.

Where interim documentation has been submitted, submit a composite results package containing all records at project closeout.

Where the installation includes re-use of existing cabling and/or components, documentation shall include a summary of such materials including manufacturer/part and where used.

Test Data - Copper Media

Test results shall include a record of test frequencies, cable type, conductor pair and cable I.D. (see 27 05 53), measurement direction, test equipment type, model and serial number, calibration date, test date, reference setup, and crew member name(s).

Submit Test Results for each Horizontal Link and each Backbone Cable in electronic form as follows:

In the native format of the test instrument (e.g., .flw for Fluke, .sdf for Agilent or Ideal, etc.).

Summarized in a fashion that includes of key test parameters and Margin(s) (Headroom) for each cable. The Summary shall be in Adobe Acrobat (.pdf) format and include all records. Individual .pdf documentation of individual records (e.g., for each horizontal cable) is not required.

Individual records for Horizontal Cabling shall identify Outlet ID using a consistent format for all records to allow for sorting.

Cross-Connect Data

Where applicable, provide assistance to allow Owner and/or Internet/Telephone Service Provider personnel to make the necessary connections to establish and/or maintain service on the new cable system. These activities include but are not limited to (1) a general wiring overview and (2) detailed cross-connect documentation (relating EO I.D., Room Number and Riser pair). The latter shall be in the form of an electronic format database (MS Excel or convertible format). An example Template is available from the DFD.

Test Data - Fiber Optic Media

Test results shall include a record of test wavelengths, cable type, cable and fiber I.D., measurement direction, test equipment type, model and serial number, calibration date, test date, reference setup, and crew member name(s).

Use United States customary units (e.g., “feet”) rather than International System units (SI; metric) unless otherwise instructed.

Submit Attenuation (Insertion Loss) Test Results for each fiber in electronic form as follows:

In the native format of the test instrument.

Summarized to include a list of all fibers and the corresponding attenuation values. The Summary shall be in Adobe Acrobat (.pdf) format and include all records.

Attenuation values should document actual measured Loss and not “Headroom” relative to the Pass/Fail limit.

Submit OTDR in electronic form in the native format of the test instrument.

Document connector end-face condition per IEC 61300-3-35 (inter-building backbone cabling only).

Record Drawings

Provide Record Drawings which denote as-built information.

Include cable routes and outlet locations.

Identify Telecommunications and other low-voltage Outlet locations by their sequential number as defined elsewhere in these documents. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided. Place outlet numbering close to the Equipment Outlet. Suggest using White background (fill) on congested drawings. It is acceptable to obscure some drawing content – furniture, for example – to improve clarity of ID text.

The DFD will provide floor plans in electronic (*AutoCAD* .dwg) format on which as-built construction information can be added. Modify these documents to denote as-built information as defined above and return to the Engineer for acceptance. Coordinate the schedule for creation of these drawings, including interim and final sets, during construction to accommodate scheduled occupancy.

Refer to DFD “CAD Standards Manual” for file format, naming and other applicable guidelines.

Identify each drawing submitted by the Contractor as part of the Project Documentation as a “Record Drawing” (RD) and include a) the contractor name and/or logo, and b) the date of the drawing.

Retain all fonts, color, layer, Model Space/Paper Space conventions established in the base drawings by the Contractor in preparation of the As-built drawings.

Prior to generation of the drawings, provide a sample plot (PDF) and CAD (.dwg) file to the Engineer for review and approval.

All documentation, including hard copy and electronic forms shall become the property of the State.

Construction Verification

Provide applicable construction Verification Checklists included in specification Section 27 08 00 and in accordance with the procedures defined for in specification Section 01 91 01 or 01 91 02.

Delete if there is no Site / Outside Plan work included in the project scope.

Site / Outside Plant Documentation

Provide documentation of inter-building cable and new and existing routes to allow the agency to update existing drawings and tables.

Include:

Ductbank Conduit utilization.

Directional Bore or Direct Buried information.

Manholes/Vaults and Handholes used.

Confirm the availability of existing records with the agency.

Training

Provide training covering the installed system to Agency Staff, and/or contract maintenance personnel.

Training to include:

* Overview of System Topology and General Concepts
* Overview of Products Used
* Overview of Labeling Formats
* Overview of Test Results and their meaning
* Overview of Documentation (Record Documents, O&M Manuals)

Other project team members (e.g., DFD Project Manager, Engineer, others) may, at their discretion, participate in the session as a presenter.

Coordinate with DFD Construction Representative, Agency Staff, and Engineer to schedule session(s). Provide adequate notification to accommodate participant schedules.

Training shall be held [at Project Site][via a Remote Meeting] and shall be conducted during normal working hours.

Discuss number of Training Sessions with Agency to accommodate staff schedules. For Corrections projects, require minimum of (2) Training Sessions. Confirm paper copy requirements with agency. DFD no longer require any paper copies.

For purposes of bidding, assume [#] Training Session(s). Coordinate training with Agency to accommodate staff schedules.

Number of Students per session shall be 6 or less.

Provide electronic copies of training material [plus [(#)] paper copies][plus paper copies for each student plus [(#)] additional copies].

The DFD and/or agency reserve the right to record session(s) for use as future refresher materials for Agency technical staff.

Warranty

See Division 1, GENERAL CONDITIONS, and GENERAL REQUIREMENTS - Guarantee Documents for general requirements.

Where all materials are contractor-provided, minimum Warranty Period for Structured Cable System sub-systems shall be as follows:

Horizontal Copper Permanent Link – 15 years. Warranty shall be direct from manufacturer(s) of cabling and connecting components to Owner.

Exception: Where cabling is terminated in a modular plug, such links shall be covered by a 2-year system warranty. Cabling and Connecting Components shall carry a 15-year manufacturer’s component warranty.

Exception: Where the project includes re-use of existing cabling and/or components or installation of agency-furnished materials, contractor warranty shall be per Division 1 and cover contractor-provided materials. Cable and connecting component warranties shall be as indicated above.

Copper Backbone – 2 years.

Fiber Optic Backbone – 2 years. Cabling and Connecting Components shall carry a 15-year manufacturer’s component warranty.

Edit to include any specialty cabling. Otherwise, delete.

Other - [ADD language as required for hardware and/or cabling additions that are unique to the project. Otherwise delete.]

Warranties shall include all labor, material, and travel time.

Submit documents to manufacturer as required for Extended Warranties.

END OF SECTION