SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS
BASED ON DFD MASTER SPECIFICATION DATED 03/01/23

PART 1 - GENERAL

Applicable provisions of Division 0 and 1 shall govern work of this Section.

CONTENTS

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals

PART 2 - PRODUCTS
- GeneralPathways
- Cable and Termination Hardware
- SYSTEMS
- Miscellaneous

PART 3 - EXECUTION
- GeneralPathways
- Horizontal Cable and Termination Hardware
- Backbone Cable – Copper and Fiber Optic
- Termination Blocks

Fiber Optic Patch Panels

SCOPE

This Section describes the general, product and execution requirements relating labeling of all communications cabling, terminations and related sub-systems for the Project.

Unless specifically included in this Section, requirements for labeling of pathway items – Junction and Pull Boxes, Communication Conduit, Surface Raceway, and Cable Tray – are covered in the respective Division 26 sections covering those items.

Provide all labeling as detailed in this and related Sections.

RELATED WORK

Section 26 05 53 - Identification for Electrical Systems; re: labeling of conduit, boxes, etc.
Section 26 05 26 - Grounding and Bonding for Electrical Systems; re: component labeling
Section 27 10 00 - Structured Cabling

REFERENCES

ANSI/TIA-606-B - Administration Standard for Telecommunications Infrastructure

SUBMITTALS

Prior to labeling of cabling, connectivity, hardware, etc., provide samples of all label types planned for the Project.

Samples shall include the intended lettering type(s) and sizes to be used.

Mount samples on 8 1/2” x 11” sheets and mark to indicate their proposed use. Submit scanned image(s) of the mounted samples.

PART 2 - PRODUCTS

GENERAL

All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED unless specifically exempted by the language of this Section.

Labels and markings shall be physically and chemically resistant to damage that would affect readability.

Embossed tape will not be permitted for any application.

Labels shall match hardware layout and design and shall be as large as possible while fitting properly.

Refer to Part 3 for labeling formats and content.

Use of installing company logo on any labeling is not permitted.

Exception: Where included for warranty and/or maintenance purposes, such labeling is acceptable.

PATHWAYS

Innerduct

Label shall be a durable Yellow plastic tag that reads, "CAUTION FIBER OPTIC CABLE" and includes blank spaces for adding information about the cable(s) contained within the innerduct.

Tag shall incorporate holes/slots for use in securing to innerduct using self-locking ties.

CABLE AND TERMINATION HARDWARE

Cable Labels

Labels shall be Wrap-around, adhesive type or – for Inter-Building Backbone Cables only – plastic label that is secured to the cable.

Flag type labels are not allowed.

Wrap-around Labels shall be:

- White Vinyl or other appropriate substrate and incorporate a clear lamination that, when label is wrapped around cable, covers printed part of label.
    - Of adequate size to accommodate circumference of cable(s) being marked and properly self-laminate over full extent of printed area of label. Labels on larger cables (e.g., Copper Backbone) may be wrapped with clear non-removable tape.

Equipment Outlet

Equipment Outlet labels that are placed in recessed label holders shall be white paper on which outlet information is added.

Modular Patch Panel

Paper Inserts integral to patch panel, Adhesive labels or factory-screened numbering.

Fiber Optic Patch Panel

Paper Inserts integral to patch panel, Adhesive labels or factory-screened numbering.

Termination Blocks

Labels for 110-type Termination Blocks shall be paper inserts and be color-coded to indicate the block's place in the cabling hierarchy (backbone, horizontal, etc.). Refer to Part 3 for insert colors.

SYSTEMS

Refer to applicable specification section for system-specific labeling requirements.

MISCELLANEOUS

PART 3 - EXECUTION

GENERAL

Clean surfaces before attaching labels with the label manufacturer's recommended cleaning agent.

Install labels firmly as recommended by the label manufacturer.

Install labels square and neatly on all equipment.

Position labels as to be visible and not obscured by termination hardware or other cabling.

Lettering shall be 10-point or larger unless noted otherwise.

This is inclusive of each voice, data, video, or fiber optic outlet, or any configuration thereof, as identified on the Drawings.

Label each component using a unique code identifying the link.

Equipment Outlet

The format of the Equipment Outlet identifier shall be as follows:

= a

BACKBONE CABLE – COPPER AND FIBER OPTIC

General

Label backbone (inter- and intra-building, and tie) cables with a unique code.

Label at each termination location, at each intermediate pull box and handhole/manhole, and where a cable passes through an intermediate Equipment Room. Where installed in cable tray, label at 25-foot intervals.

At manhole locations, label each cable twice – once each at entry and exit conduit.

At end points, place label within 12" of the termination (e.g., entrance to a Fiber Optic Termination Enclosure or Copper Termination Block).

Adjust labeling interval to ensure that tags are visible.

Where a plastic label is used (e.g., not wrap-around type), secure the tag to the cable using self-locking ties.

Cable Designation

Identify each cable with a unique designator to identify the end locations where the cable is terminated (e.g. cross-connect location at ER, HC, etc.).

Fiber type designations for fiber optic cable shall be as follows:

- 62.5/125µm (core/cladding) multimode MMF62
- 50/125µm LASER-Optimized multimode MM50
- Single-mode OS2

Backbone Cabling - Inter-Building

Label Inter-Building (between buildings) cabling with:

- Origin and Destination locations (e.g., “From” & “To”)
  Designation will differ (To/From) at opposite ends of the cable
- Fiber type(s) (Fiber Optic Cable only)
- Pair Count or Fiber Count
- Year Installed

Example (Fiber Optic):

Label for fiber optic cable containing (24) OS2 Single-mode fibers installed October 2019 from Building 123 Main Cross-connect (MC123) to Building 456 Main Cross-connect (MC456) would appear as follows:

MC123-MC456 24-OS2 10/2019

Network Connection Cabling

Designation Strips for Blocks on which cabling from Access/Service Provider (Feed) is terminated shall be GREEN.

Label Designation Strips with:

- Designation as "NETWORK (*PROVIDER NAME)*”. Repeat on every designation strip.
- Pair Number.

Example: Designation strip for block on which Service Provider (AT&T in this example) pairs 1001 – 1050 are terminated would appear as follows:

- - - - - Conductor Positions - - - - -

1001	NETWORK (AT&T)	1025
1026		1050

- - - - - Conductor Positions - - - - -

END OF SECTION

SECTION 27 08 00
COMMISSIONING OF COMMUNICATIONS
BASED ON DFD MASTER SPECIFICATION DATED 03/01/23

PART 1 - GENERAL

SCOPE
This section includes commissioning forms for construction verification and functional performance testing. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Submittals

PART 2 - PRODUCTS
- (Not Used)

PART 3 - EXECUTION
- Commissioning When No Forms Are Available
- Commissioning Forms:
  - CV-27 05 53 Identification for Communications Systems
  - CV-27 10 00 Structured Cabling
  - CV-27 16 19 Communications Patch Cords, Station Cords, and Cross-Connect Wire

RELATED WORK
Section 01 91 01 or 01 91 02 – Commissioning Process

Section 27 08 41 – AV Systems Commissioning

REFERENCE
Applicable provisions of Division 1 shall govern work under this section.

SUBMITTALS
Reference the General Conditions of the Contract for submittal requirements.

Reference Section 01 91 01 or 01 91 02 Commissioning Process for Construction Verification Checklist and Functional Performance Test submittal requirements.

PART 2 – PRODUCTS

(Not Used)

PART 3 – EXECUTION

COMMISSIONING FORMS
Commissioning forms are to be filled in as work progresses by the individuals responsible for installation and shall be completed for each installation phase.

Provide a description of the work completed since the last entry, the percentage of the total work completed for the system for that area and the step of installation or finalization.

Circle Yes or No for each commissioning form item. If the information requested for an item does not apply to the given stage of installation for the system, list it as “N/A”. Explain all discrepancies, negative responses or N/A responses in the negative responses section.

Once the work is 100% complete and the responses to each item are complete and resolved for a given commissioning forms group, mark as complete, initial and date in the spaces provided.

Provide copies of the commissioning forms to the commissioning agent 2 days prior to construction progress meetings.

CV-27 05 53 – Identification for Communication Systems

Equipment Identification/Tag: _____
Location: _____

A) LABELING

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)									
				1)	2)	3)	4)	5)	6)	7)	8)	9)	10)
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
				YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
❑ CHECKLIST GROUP COMPLETE				INITIALS: _____					DATE: _____				

Question Details

1) Equipment Outlet faceplates labeled as specified.
2) Cabling at Equipment Outlet labeled as specified.
3) Termination Blocks for Backbone Copper Cable (including Building Entrance Terminal) labeled using correct color-coded (WHITE, GRAY or BROWN) Designation Strips
4) Fiber Optic Patch Panels for backbone fiber optic cabling labeled as specified.
5) Copper Cabling at Modular Patch Panels and Termination Blocks at Main Equipment Room and Telecom Room(s) labeled in accordance with specification requirements.
6) Backboard, Equipment Racks and Cabinets, and Enclosures labeled as specified.

Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

CV-27 16 19 – Communications Patch Cords, Station Cords, And Cross-Connect Wire

Equipment Identification/Tag: _____
Location: _____

A) COMMUNICATIONS PATCH CORDS, WORK AREA CORDS, AND CROSS-CONNECT WIRE

Date	Description of Work Performed	% Complete	Initials	Questions (See details below)									
				1)	2)	3)	4)						
				YES NO	YES NO	YES NO	YES NO						
				YES NO	YES NO	YES NO	YES NO						
				YES NO	YES NO	YES NO	YES NO						
				YES NO	YES NO	YES NO	YES NO						
				YES NO	YES NO	YES NO	YES NO						
				YES NO	YES NO	YES NO	YES NO						
				YES NO	YES NO	YES NO	YES NO						
				YES NO	YES NO	YES NO	YES NO						
❑ CHECKLIST GROUP COMPLETE				INITIALS:		_____			DATE:		_____		

Question Details

Note: Confirmation of delivery includes documentation confirming said delivery.

1) Fiber Optic Patch Cords delivered to Agency.
2) Copper Twisted Pair Patch Cords and Work Area Cord Cords delivered to Agency.
3) Coax Patch Cords and Work Area Cords delivered to Agency.
4) Cross-connect wire and Spool holders delivered to Agency.

Negative Responses

Group/ Item	Date Found	Found By	Location	Reason for Negative Response	Resolved	Date Resolved	Resolution
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		
					YES / NO		

SECTION 27 10 00
STRUCTURED CABLING
BASED ON DFD MASTER SPECIFICATION DATED 09/03/24

PART 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
- Scope
- Related Work
- References
- Design Intent
- Quality Assurance
- Submittals
- Schedule

PART 2 - PRODUCTS
- Backbone Fiber Optic Cable
- Fiber Optic Splice Hardware
- Fiber Optic termination Enclosure
- Flexible Nonmetallic Innerduct and Fittings

PART 3 - EXECUTION
- General
- Equipment Rack Layout
- Salvage Materials
- Cleaning and Inspection
- Backbone Cable System Topology and Cable Size Requirements
- Cable Installation
- Innerduct
- Cable Termination
- Identification and Labeling
- Testing and Acceptance
- Documentation
- Training
- Warranty

RELATED WORK
Applicable provisions of Division 1 govern work under this Section.

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 53 – Identification for Electrical Systems
Section 27 05 53 – Identification for Communications Systems
Section 27 08 00 – Commissioning of Communications
Section 27 11 13 – Communications Protection

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

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.

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.

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.

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.

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

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.

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.

PART 2 - PRODUCTS

Inter-Building Backbone Twisted-Pair Copper Cable

Installation of this cable type in underground duct is typical. Requirements for Direct burial occur on occasions. 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.

BACKBONE FIBER OPTIC CABLE

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.

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).

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

Cable Rating: OFNP (Optical Fiber Non-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: -40° to +70°C (no irreversible change in attenuation)
Operating -40° to +70°C
Installation 0° to +60°C

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

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.

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.

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

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

Cable Rating:

- 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:

- Security Card Access Controller Location
  Performance Exceed Category 6
  Cable type 4-pair UTP
  Cable Jacket Color Blue
  Terminate in 8P8C Modular Jack
  Modular Jack/Plug Pinning and Color
  T568A Color Blue

- Outdoor and "Wet" Location(s)
  Performance Exceed Category 6
  Cable type 4-pair F/UTP
  Cable Jacket Color N/A; Typically, Black or Gray
  Modular Jack Pinning and Color
  Same as Workstation Link

FIBER OPTIC SPLICE HARDWARE

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.

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

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.

MODULAR PATCH PANEL

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

Jack colors should match those used at the Equipment Outlet.

Modular Patch Panel shall be wall-mounted.

Rack –mounted panel shall be Flat

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.

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

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.

FIBER OPTIC TERMINATION ENCLOSURE

Fiber Optic Connector

The Optical Connector shall be 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.

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 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.

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.

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).

PART 3 - 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.

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.

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

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.

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 - 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.

All jack positions in a row shall be populated.

Cables designated for various systems (e.g., Network, Security) shall be terminated on shared 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

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.

IDENTIFICATION AND LABELING

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.

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:

a) 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.

b) 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:

a) Optical Attenuation
b) Verification of Link Integrity and component losses
For projects at University of Wisconsin – Milwaukee, include the following:
c) 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 <u>or</u> 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.

DOCUMENTATION

General

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

Submit all documentation in electronic form.

In addition, provide (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 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 - 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.

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 and shall be conducted during normal working hours.

For purposes of bidding, assume 2 Training Sessions. 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 (1) paper copies plus paper copies for each student plus (1) 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:

Copper Backbone – 2 years.

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

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

Submit documents to manufacturer as required for Extended Warranties.

END OF SECTION

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SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS
BASED ON DFD MASTER SPECIFICATION DATED 03/01/23

PART 1 - GENERAL

SCOPE
This Section describes the general, product and execution requirements relating to equipment required in the fit-out of the Communications Equipment Room(s) for the project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals

PART 2 - PRODUCTS
- Equipment Rack
- Equipment Cabinet (Wall-mount)
- Miscellaneous Materials

PART 3 - EXECUTION
- General
- Equipment Rack (Wall-mount)
- Cable Runway
- Grounding and Bonding
- Miscellaneous

RELATED WORK
Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process
Section 26 05 26 – Grounding and Bonding for Electrical Systems
Section 27 05 53 – Identification for Communications Systems
Section 27 08 00 – Commissioning of Communications
Section 27 10 00 – Structured Cabling

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 are as follows:
- ANSI/IEEE C2 - National Electrical Safety Code
- SPS Chapter 316 – Wisconsin Dept. of Safety and Professional Services Electrical Code
- TIA-568-C.0, -568-C.1, -568-C.2, -569-C, -606-B and TIA-607-C (with exception) and standards referenced therein
- IEEE/ANSI 142-1982 - Recommended Practice for Grounding of Industrial and Commercial Power Systems
- EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment
- UL 2416 - Standard for Audio/Video, Information and Communication Technology Equipment Cabinet, Enclosure and Rack Systems

SUBMITTALS
Refer to Section 27 10 00 – Structured Cabling.

PART 2 - PRODUCTS

EQUIPMENT RACK

General

Refer to the project Drawings for quantities required at each location. Where additional Equipment Racks are required or where existing racks are in place and none are required, it shall be so noted on the Project Drawings.

Equipment Rack shall comply with State Building Codes for the seismic area where installed.

Rack shall be 84" in height and shall be self-supporting.

Upright Mounting Channel (E-Rail on 4-post racks) spacing: Per EIA/ECA-310 to accommodate Industry standard 19” mounting.

Construction:

Material: Aluminum

Finish: Powder coated or painted surface

Color: Black

Upright Mounting Channel/Rail shall be drilled and tapped to accept 12-24 screws.

Vertical hole spacing: Per EIA/ECA-310 (5/8"-5/8"-1/2")

Upright Mounting Channels/Rails shall be marked with Rack Unit (RU) identifiers per ANSI/TIA-606-B. Numbering shall be “bottom-to-top” (e.g., “#1” at bottom of rack).

For each rack, provide:

- Mounting Screws; 12-24 (24 minimum quantity)
- Ground Bar and #6 AWG Ground lug

Jumper Management

Rack shall be equipped with Vertical 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.

Hardware shall provide for cable routing on front and, for 2-post construction, rear of each rack.

Vertical managers shall:

- Have non-metallic “fingers” spaced at 1.75” (1 Rack Unit; RU) aligned with each Rack Unit indicator on the equipment rack. Surface of fingers shall be curved to support cable bend radius goals.
- Be equipped with hinged front and, for 2-post construction, rear doors that cover the cable routing area.

Channel dimensions: Minimum width: 6” at end-of-row, 8” between adjacent racks or as shown on project drawings.

Hardware shall be designed to mount in a way that does not use holes intended for mounting of hardware and equipment and allows for full use of the equipment rack.

- Where multiple racks are to be installed, mount hardware between the uprights of adjacent racks.
- Secure rack uprights and spacers together per manufacturer recommendations.

EQUIPMENT CABINET (WALL-MOUNT)

Where identified on the drawings, wall mounted equipment cabinets shall house all termination components installed under this contract.

Be of a "three-section" construction including (a) wall-mount section that incorporates cable entry, (b) center section and (c) Door. Each section shall be hinged to facilitate access. Hinges shall be configurable to open LEFT OR RIGHT.

The Wall-mounted section shall incorporate knockouts (top and bottom) for cable access.

Include lockable doors when requested by the Agency where the need is otherwise determined. The Door shall be solid. Door depth shall be 2-inches or greater. [Door shall be lockable and furnished with two (2) keys. Doors on all cabinets furnished under this contract shall use the same key.]

Door shall be at least 25-inches in width. (It is understood that this may require a custom configuration. Use of standard cabinet designs with extended mounting rails is to be considered).

Hardware mounting depth (from front of channel upright to wall) shall be 18-inches (minimum).

[Provide Fan/Filter Kit at top and bottom of enclosure to ensure adequate airflow. Position Fan/Filter at top on side opposite location of the Fan/Filter on bottom.]

The cabinets shall be constructed of painted Steel or Aluminum.

Dimensions:

Minimum usable mounting height – 60" to the top of cabinet AFF.

Mounting depth – 21 inches

Cabinet shall have a load-bearing capacity of 100 150 lbs. or greater.

The cabinet shall be configured to allow for adjustment of the channel uprights (front to rear) in 1-inch increments, spaced to accommodate industry standard 19-inch mounting, and tapped to accept 12-24 screws. The cabinet shall be vented to allow for airflow through the cabinet.

Cabinet(s) shall be equipped with vertical and horizontal cable management hardware, in the form of rings and guides, as to allow an orderly routing of optical fiber and twisted pair jumpers from the patch panel to the customer provided network equipment. At a minimum, provide one such horizontal jumper management panel with each cabinet.

MISCELLANEOUS MATERIALS

Power Strip / Surge Suppressor

Power Strip / Surge Suppressor shall:

Be rack mountable (19-inch rack)

Be compliant with UL-1449, UL-1283 and UL-497A.

Provide Transient suppression to 13 kA. Protection shall be in all 3 modes (hot-neutral, hot-ground & neutral-ground).

Meet or exceed IEEE 587 Category A & B specification.

Provide High Frequency Noise Suppression as follows:

>20 dB @ 50-kHz

>40 dB @ 150-kHz
>80 dB @ 1-MHz
>30 dB @ 6- to 1000-MHz

Provide a minimum of 320 Joules of AC Energy Absorption.

Be equipped with a 12-foot power cord

Provide a minimum of six (6) outlets

Electrostatic Discharge (ESD) Kit
Lug:
Two-hole Mounting
Accommodates standard ESD wrist strap 4mm plug
Barrel marked with the ground symbol
Wrist Strap:
Adjustable fabric strap with 6' coil cord, 4 mm plug, resistor.

PART 3 - EXECUTION

GENERAL
Refer to Project Drawings that indicate Equipment Room layout

Furnish and install 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.

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. All work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

EQUIPMENT RACK (WALL-MOUNT)
Confirm location of rack/cabinet to ensure equipment access and clearances, including when assembly is rotated as required to provide access to back of mounted equipment.

Mount per manufacturer’s recommendations.

Use anchoring means appropriate for the wall type and to support the rated load of the Cabinet.

CABLE RUNWAY
Provide cable runway and accessories necessary for complete system.

Size and layout cable runway per project Drawings.

Install per manufacturer’s recommendations with cross- members (rungs) at the top of the stringer.

Brace to racks with support brackets made by runway or rack manufacturer and intended for this purpose. Method shall provide adequate clearance for use of cable dropouts and to maintain cable bends to greater than recommended minimums.

Provide radius drops where cables drop from Cable Runway to Equipment Rack and at elevation changes of 6 inches or more.

Support at wall and at intermediate points not supported by equipment racks per manufacturers recommendations. Maximum allowable deviation of runway from level horizontal plane measured across length of cable runway shall be 5/8 inch, with tray loaded to capacity.

Fasten cables to cable runway at intervals not to exceed 48 inches using hook and loop cable ties.

GROUNDING AND BONDING

Ground per specification Section 26 05 26 and manufacturers recommendations.

Bonding Conductor may be routed unenclosed on Cable Runway and on Equipment Rack.

Equipment Racks and Cabinets

Bond each rack and cabinet via on-rack ground bar or grounding strip to the Telecommunications Ground Busbar (TGB) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket or GREEN jacket with one or more yellow stripes per NEC paragraph 250.119).

Bond each rack to the TGB via a separate conductor.

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

Install ground bar such that there is a bond between it and rack/cabinet. Remove paint from the rack/cabinet at the connection point. Use thread-forming (paint piercing) type mounting screws.

Cable Runway

Use manufactured straps between spliced sections per manufacturer's recommendations.

Bond each segment to Telecom Grounding Busbar in room.

MISCELLANEOUS

Power Strip / Surge Suppressor

Unless noted otherwise on project drawings, provide (1) Power Strip / Surge Suppressor at each equipment rack for powering of the network electronics (by others):

> At the Main Equipment Room.
>
> At <u>each</u> Telecommunications Room (as applicable).

Install per manufacturer's recommended practices.

Electrostatic Discharge (ESD) Kit

Provide ESD Kit(s) in each Telecom Room.

Where (1) kit will not allow user to reach all racks, provide multiple kits. Consider both left- and right-handed use.

Provide (1) kit for each free-standing cabinet.

END OF SECTION

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SECTION 27 16 19
COMMUNICATIONS PATCH CORDS, WORK AREA CORDS, AND CROSS-CONNECT WIRE
BASED ON DFD MASTER SPECIFICATION DATED 03/01/23

PART 1 - GENERAL

SCOPE
This section describes the general, product and execution requirements relating to furnishing of Communications Patch Cords, Work Area Cords and/or Cross-Connect Wire for the project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Quality Assurance
- Submittals

PART 2 - PRODUCTS
- Copper Twisted Pair Patch Cords and Work Area Cords
- Fiber Optic Patch Cords
- Cross-Connect Wire

PART 3 - EXECUTION
- General
- Configurations and Quantities
- Warranty

Refer to PART 3 for quantity, color (if applicable), length and configuration of each item.

RELATED WORK
Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process
Section 27 10 00 – Structured Cabling

REFERENCES
See Section 27 10 00 – Structured Cabling.

QUALITY ASSURANCE
Patch Cords and Work Area Cords shall be factory manufactured. Field-assembled cords are not acceptable.

Cords shall be 100% factory tested.

SUBMITTALS
See specification Section 27 10 00 - Structured Cabling.

Upon request, submit samples of each Patch/Work Area Cord planned for project.

PART 2 - PRODUCTS

COPPER TWISTED PAIR PATCH CORDS AND WORK AREA CORDS
General
For purposes of this section, “Patch Cords” refer to those cords used at the Horizontal Cross-connect; Work Area Cords are those used in the user/work area to connect between the horizontal cabling and user devices.

In a Zone Cabling installation, the cables between the Consolidation Point (CP) and the Equipment Outlet (EO) are considered part of the Permanent Link. Refer to specification Section 27 10 00 for requirements, if applicable.

Patch Cords and Work Area Cords shall be labeled with (1) manufacturer part number and (2) length (if not included in par number). At least one end of the cord shall be labeled.

Modular Plugs shall incorporate Strain-relief and be a Snag-less design. Size of the assembly shall allow for patch cords to be positioned in adjacent ports of Modular Patch Panel specified in Section 27 10 00 - Structured Cabling and agency network electronics. Confirm fit with agency.

Industrial/Ruggedized Work Area Cords
Cord shall be design intended for industrial application.

Patch Cord assembly shall meet performance requirements of TIA-568-C.2. See PART 3 for performance "Category" requirements.

Construction:
- 4-pair; 24 AWG solid copper twisted pairs.
- Unshielded (UTP)
- 8-Position, 8-Conductor (8P8C) Modular Plug at both ends.
- Cable jacket shall be industrial grade design and be UV and oil-resistant.

Multimode Patch Cords
General specifications above shall apply.

Cable jacket color shall indicate fiber type as follows:
- 62.5-micron; OM1 - ORANGE
- 50-micron LASER-optimized; OM3 – AQUA

Single-mode Patch Cords
General specifications above shall apply.

Cable jacket color shall be YELLOW to indicate fiber type.

CROSS-CONNECT WIRE
Cross-connect wire shall be:
- 24-AWG, Copper Twisted-pair
- Unjacketed

Insulation color:
- 4-pair - white-blue/blue, white-green/green, white-orange/orange & white-brown/brown
- 1-pair - white-blue/blue or white-green/green (Refer to PART 3)
- 2-pair - white-blue/blue & white-green/green

Spool holders, where applicable, shall be assemblies designed for that purpose. Refer to Section 27 10 00 - Structured Cabling.

PART 3 - EXECUTION

GENERAL
Furnish Patch/Work Area Cords and/or Cross-connect Wire in the configuration(s) and quantities. Confirm actual requirements with agency during construction.

Quantities, jacket color(s) and length(s) indicated are for purposes of bidding. Confirm actual requirements with agency during construction.

Method of Delivery
Where required by Section 27 10 00 – Structured Cabling, install Patch Cords and/or Cross-connect Wire to construct cross-connect between horizontal and backbone cabling.

Where contractor-furnished Patch Cords, Work Area Cords and/or Cross-connect Wire are to be agency-installed, furnish per Division 1 - General Requirements, “Loose and Detachable Parts”.

Where contractor is responsible for installation of Patch/Work Area Cords and/or Cross-connect Wire, this is noted in Section 27 10 00 – Structured Cabling, and/or Project Drawings.

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

CONFIGURATIONS AND QUANTITIES
Copper Twisted Pair Patch Cords and Work Area Cord
4-pair Modular Patch/Work Area Cord:
- Performance: TIA Category 6
- Jacket Color: Blue

4-pair Modular Patch/WAP Cord:
- Performance: TIA Category 6
- Jacket Color: Blue

Modular-to-110 Patch Cord:
- Performance: TIA Category 3
- Jacket Color: Blue

Fiber Optic Patch Cords
Fiber Type: Multimode MMF62 62.5/125 µm

Fiber Type: Single-mode OS2
- Ferrule Polish - Ultra-Physical Contact (UPC) Contact (UPC) one end; Angled Physical Contact (APC) one end.

WARRANTY
See Division 1, General Conditions, and General Requirements - Guarantee Documents

Manufacturer shall replace components that fail in materials or workmanship within specified warranty period.

Warranty Period (minimum):
- Twisted Pair Modular Patch Cords – 5 years
- Modular-to-110 Patch Cords – 5 years
- Fiber Optic Patch Cords – 5 years

Warranty shall be direct from the cord manufacturer(s) to Owner.

END OF SECTION

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