ADDENDUM NUMBER 1
November 12, 2019

Upham Woods Administration Building Replacement Project REBID
University of Wisconsin - Extension
N194 County Road N
Wisconsin Dells, Wisconsin 53965

From: Zimmerman Architectural Studios, Inc.
2122 West Mt. Vernon Avenue
Milwaukee, Wisconsin 53233

To: Prospective Bidders

This Addendum is issued to modify, explain, and amend the originally issued Specifications and Drawings dated November 6, 2019 and is hereby made a part of the Contract Documents. Please acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may result in Bidder disqualification.

PLEASE INSERT THIS ADDENDUM IN THE PROJECT MANUAL

SPECIFICATIONS

MEP & GPC Invitation to Bid
ADD Jacob Dwyer as additional contact for any drawing and specification inquiries:

Jacob Dwyer, UWSA
Procurement Specialist
780 Regent St
Madison, WI 53715
jdwyer@uwsa.edu

DELETE reference to Prevailing Wage Rates
"...Prevailing wage rates are applicable to this project. Those rates are included in the Supplementary General Conditions of the Contract the General Prime Contractor will be required to enter into with the Owner."

MEP & GPC Instructions to Bidders
DELETE Article 10 from the Project.

10. DISCLOSURE OF OWNERSHIP
The Bidder shall disclose on the date of submitting a bid for this project, the name of any construction business of which the Bidder has had a 25% or greater interest as a shareholder, officer, partner, or owner at any time during the preceding three (3) years, if said construction business has been found by the Department of Workforce Development to have failed to pay the prevailing wage rate or at least 1.5 times the hourly basic rate of pay for hours worked in excess of the prevailing hours of labor to any employee at any time within the preceding three (3) years.

The "Disclosure of Ownership" form may be obtained at no charge from the Department of Workforce Development, Equal Rights Division, P.O. Box 8928, Madison, Wisconsin 53708.

MEP & GPC Front End - Exhibit ‘C’
ADD the following to Exhibit ‘C’

EXHIBIT C.3 - Existing Administration Building: Wall Tile/Mastic & Vermiculite Insulation
EXHIBIT C.4 - Existing Lodge Building: Vinyl Cove Base (Interior) & Exterior Asphalt Shingles
EXHIBIT C.5 - Existing Lodge Building: Wood Siding, Tar Paper & Kraft Paper Fiberglass Insulation
Section 07 13 00 – Membrane Waterproofing
PART 2 – PRODUCTS; PROTECTION BOARD, ADD ACH Foam Technologies “Foam-Control+” 25 psi XPS board as an approved equal.

Section 10 28 25 – Electric Hand Dryers
PART 2 – PRODUCTS; MANUFACTURERS, ADD Saniflow Corp. “Dualflow Plus” as an approved equal.

Section 27 05 53 – Identification for Communications Systems
ADD this Section to the Project Manual.

Section 27 08 00 – Commissioning of Communications
ADD this Section to the Project Manual.

Section 27 10 00 – Structured Cabling
ADD this Section to the Project Manual.

Section 27 11 00 – Communications Equipment Room Fittings
ADD this Section to the Project Manual.

Section 27 11 13 – Communications Protection
ADD this Section to the Table of Contents and Project.

Section 27 16 19 – Communications Patch Cords, Word Area Cords and Cross-Connect Wire
DELETE this Section from the Table of Contents and Project.

DRAWINGS

SHEET E100 - ELECTRICAL SITE PLAN
REVISE Plan Note #2:

“2. PROVIDE/INSTALL (1) 2” UNDERGROUND CONDUIT & (2) OUTSIDE RATED CAT. (6A) (F/UTP) DATA CABLES FROM NEW WELCOME CENTER TO STAFF DUPLEX. PROVIDE/INSTALL PROTECTION AT EACH END OF THE CAT.6 4-PAIR CABLES BETWEEN THE STAFF DUPLEX AND THE NEW ADMINISTRATION BUILDING.”

SHEET E301 - FIRST FLOOR POWER AND SYSTEMS PLAN
ADD General Note #3:

“3. COORDINATE ALL WAP LOCATIONS WITH DoIT PRIOR TO INSTALLATION.”

SHEET E302 - SECOND FLOOR POWER AND SYSTEMS PLAN
ADD General Note #3:

“3. COORDINATE ALL WAP LOCATIONS WITH DoIT PRIOR TO INSTALLATION.”

- End of Addendum No. 1 -
**Attention:** Christopher Heidel  
University of Wisconsin Safety EHS  
30 East Campus Mall  
Madison, WI 53715

**Project:** UPHAM WOODS- CENTRAL LODGE (BLDG # 0245)- SIDING TAR PAPER & KRAFT PAPER (PO BD28405 141665)

### Test Report: Asbestos Analysis of Non-Friable Organically Bound Materials by PLM via EPA 600/R-93/116 section 2.3

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Description</th>
<th>Appearance</th>
<th>% Matrix Material</th>
<th>% Non-Asbestos Fibers</th>
<th>Asbestos Types</th>
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<tbody>
<tr>
<td>2019-5871</td>
<td>UPHAM WOODS - CENTRAL LODGE (BLDG #0245) RM 8 - KRAFT PAPER FACE TO FIBERGLASS INSULATION</td>
<td>Brown/Various/Black Fibrous Homogeneous</td>
<td>100 Other</td>
<td>None</td>
<td>No Asbestos Detected</td>
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<td>2019-5872</td>
<td>UPHAM WOODS - CENTRAL LODGE (BLDG #0245) EXTERIOR - SIDING TAR PAPER</td>
<td>Various/Black Fibrous Homogeneous</td>
<td>100 Other</td>
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<td>2019-5873</td>
<td>UPHAM WOODS - CENTRAL LODGE (BLDG #0245) EXTERIOR - COMPOSITE WOOD LAP SIDING</td>
<td>Brown Fibrous Homogeneous</td>
<td>100 Other</td>
<td>None</td>
<td>No Asbestos Detected</td>
</tr>
</tbody>
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**EMSL maintains liability limited to cost of analysis.** The above analyses were performed in general compliance with Appendix E to Subpart E of 40 CFR (previously EPA 600/M4-82-020 "Interim Method"), but augmented with procedures outlined in the 1993 ("final") version of the method. This report relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. All samples received in acceptable condition, unless otherwise noted. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP. NIST or any agency of the federal government. EMSL recommends gravimetric reduction for all non-friable organically bound materials prior to analysis. Estimate of uncertainty is available on request.

**Initial report from:** 10/29/2019 14:04:34
Test Report: Asbestos Analysis of Non-Friable Organically Bound Materials by PLM via EPA 600/R-93/116 section 2.3

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<td>UPHAM WOODS-CENTRAL LODGE (BLDG 0245) RM 8 - 4&quot; DARK BROWN VINYL BASEBOARD WITH ASSOC. YELLOW MASTIC</td>
<td>Brown Non-Fibrous Homogeneous</td>
<td>100 Other</td>
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<td>No Asbestos Detected</td>
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<td>2019-5865-Mastic Base 261911025-0001A</td>
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<td>100 Other</td>
<td>None</td>
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<td>2019-5866 261911025-0002</td>
<td>UPHAM WOODS-CENTRAL LODGE (BLDG 0245) EXTERIOR - ASPHALT SHINGLE</td>
<td>Various/Black Non-Fibrous Homogeneous</td>
<td>93.8 Other</td>
<td>6.2 Glass</td>
<td>No Asbestos Detected</td>
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</table>

Analyst(s)
Samantha Miller (3)

James Hahn, Laboratory Manager
or other approved signatory

EMSL maintains liability limited to cost of analysis. The above analyses were performed in general compliance with Appendix E to Subpart E of 40 CFR (previously EPA 600/M4-82-020 "Interim Method"), but augmented with procedures outlined in the 1993 ("final") version of the method. This report relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. All samples received in acceptable condition, unless otherwise noted. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government. EMSL recommends gravimetric reduction for all non-friable organically bound materials prior to analysis. Estimate of uncertainty is available on request.

Samples analyzed by EMSL Analytical, Inc. Hillside, IL

Initial report from: 10/29/2019 14:03:32

T-18-001 Upham Woods Outdoor Learning Center - Administrative Building Replacement Project
EXHIBIT C.4 - Existing Lodge Building: Vinyl Cove Base (Interior) & Exterior Asphalt Shingles
Dear CHRISTOPHER HEIDEL:

Enclosed are the analytical results for sample(s) received by the laboratory on October 28, 2019. Results reported herein conform to the most current Industrial Hygiene standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions concerning this report, please feel free to contact the lab.

Sincerely,

Steve Strebel, Laboratory Director

Analyst - JOHN KNIGHT
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**Method**


**Analyte**

BULK ASBESTOS

**Result**

Asbestos: Not Detected

**Layer 1**

**Description**

SEA-FOAM GREEN CERAMIC TILE

**Non-Fibrous Components**

Mineral Binder

**Layer 2**

**Description**

MASTIC

**Color**

YELLOWISH-BROWN

**Texture**

Resinous

**Non-Fibrous Components**

Resin Binder

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**Method**


**Analyte**

BULK ASBESTOS

**Result**

Asbestos: Not Detected

**Layer 1**

**Description**

PEACH CERAMIC TILE

**Non-Fibrous Components**

Mineral Binder

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**Method**


**Analyte**

BULK ASBESTOS

**Result**

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According to the Environmental Protection Agency’s brochure Current Best Practices for Vermiculite Attic Insulation, May 2003, vermiculite insulation should be considered Asbestos Containing. Due to difficulties associated with conclusive detection of the presence or absence of asbestos fiber by current test methods and its unique friable nature, Wisconsin Department of Health & Family Services considers ALL vermiculite insulation as Asbestos Containing. Accordingly, under the recently revised HFS159 now in effect, all vermiculite insulation is considered Asbestos Containing regardless of previous laboratory test results and must be handled as such. This rule change only applies to construction and renovation activities covered by the WI DHFS statute.

If you have any further questions, please feel free to contact: WI Dept. Health & Family Services, Asbestos and Lead Section, at 608-261-6876.

Abbreviations:
- mg = milligrams                         ppm or ppmv = parts per million /m3 = per cubic meter
- ug = micrograms                        ppb or ppbv = parts per billion /ft2 = per square foot
- ng = nanograms                        EU = Endotoxin Units fibers/cc = fibers per cubic centimeter
- < Less Than. The analyte, if present, is at a level too low to be accurately quantitated by the method used.
Displayed values on report have been rounded; however all calculations are performed using raw, unrounded intermediate results. Please contact the laboratory if you have any questions regarding our result calculation or rounding. All samples were received by the laboratory in acceptable condition unless otherwise noted.

The results in this report apply only to the samples, specifically listed above, and tested at the Wisconsin Occupational Health Laboratory.

For Lead analysis the Wisconsin Occupational Health Laboratory (ID 101070) is accredited by the AIHA Laboratory Accreditation Programs, LLC (AIHA-LAP, LLC) in the ELLAP accreditation program(s) as documented by the Scope of Accreditation Certificate and associated Scope.

This report is not to be reproduced except in its entirety.

End of Analytical Report.
SECTION 27 11 13
COMMUNICATIONS PROTECTION
BASED ON DFDM MASTER SPECIFICATION DATED 03/01/19

PART 1 - GENERAL

SCOPE
This Section describes the general, product and execution requirements relating to equipment required in for the protection of cables entering a building. Included are the following topics:

PART 1 - GENERAL
Scope
Related Work
References
Submittals

PART 2 - PRODUCTS
Building Entrance Terminal / Protector

PART 3 - EXECUTION
General
Building Entrance Terminal / Protector
Identification and Labeling
Testing and Acceptance
Documentation
As-Built Construction Drawings
Warranty

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 00 – Common Work Results for Electrical
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.

Applicable standards include the following:
- 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 standards referenced therein
- TIA-607-C - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- UL 497 - Protectors for Paired-Conductor Communications Circuits
- UL 497B - Protectors for Data Communications and Fire-Alarm Circuits
- Telcordia GR-1089-CORE - Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment

SUBMITTALS
Refer to Section 27 10 00 – Structured Cabling.
PART 2 - PRODUCTS

BUILDING ENTRANCE TERMINAL / PROTECTOR
Network Application (Surge Protector)

Intended for use on network connection to outdoor-mounted devices (Wireless Access Point, Security Camera).

Protects high-performance 4-pair cables. All pairs protected.

Construction:
• Individual (single cable) unit
• Solid-State design.
• Interface: Input – Termination Block; Output – Termination Block
• Supports Unshielded (UTP) Cable
• Incorporates a grounding lug that will accept a #6 AWG ground wire.

Performance:
• Meets TIA Category 6
• Protects 10/100/1000 Base-T Ethernet networks.
• Provides protection for both common- and differential-mode surges.
• Supports Modes A and B of 802.11af (PoE) and 802.11at (PoE+) standards.
• Meets UL Primary (497) and Isolated Loop (497B)
• Meets UL Primary (497) and Isolated Loop (497B)
• Complies with Telcordia GR-1089-CORE (Intra-Building).

Environmental:
• Operating Temperature: -40°F – 158°F (-40°C – 70°C)
• Maximum Humidity: 90% non-condensing

PART 3 - EXECUTION

GENERAL
Refer to Project Drawings which indicate device and termination location(s).

Provide hardware and equipment as shown on drawings and as specified herein.

Comply with manufacturers recommendations for use and installation of the product.

Position Protection as close to building entrance as practicable or as noted on drawings. Document location on record documents.

If a special tool is required to open the BET housing or Protector Enclosure, provide (1) tool for each BET location. Turn over as “miscellaneous materials” to DFD Construction Representative at completion of the work.

BUILDING ENTRANCE TERMINAL / PROTECTOR

Provide a listed primary protector on all inter-building backbone copper pairs.

Provide a Surge Protector on horizontal cabling for all exterior network devices (e.g. security camera, wireless access point) as noted on project drawings. Position Surge Protector between the Equipment Outlet (or device if cabling is terminated in a modular plug) and the Network Switch serving the device.

Where a mid-span PoE Injector is used, position Surge Protector between the Equipment Outlet (or device) and the PoE Injector.

Bond Building Entrance Terminals (BET) and/or Surge Protector to an approved ground using a #6 AWG (minimum) solid copper conductor (green jacket) or per manufacturer’s installation instructions. Confirm grounding plan with DFDM prior to construction. Unless noted otherwise on drawings, assume the following grounding plan for each application:
• Surge Protector (Network application)
  - Protector at Telecom Room – Bond to Telecommunications Grounding System.
  - Protector at Building Perimeter – Bond to Telecommunications Grounding System.

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

Labeling of Surge Protectors for network applications is not required unless otherwise noted.

TESTING AND ACCEPTANCE
See specification Section 27 10 00 - Structured Cabling.

DOCUMENTATION
Refer to specification Section 27 10 00 – Structured Cabling

AS-BUILT CONSTRUCTION DRAWINGS
Refer to specification Section 27 10 00 – Structured Cabling

On Record Drawings which denote as-built information, identify device locations.

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

Building Entrance Terminal – 2 years
Surge Protector – 10-years

END OF SECTION
SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS
BASED ON DSF MASTER COMMUNICATION SPEC DATED 11/07/16

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
Cable Runway
Miscellaneous Materials

PART 3 - EXECUTION
General
Equipment Rack (Free Standing)
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
• 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

Free Standing Equipment Rack

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 Racks shall conform to the following requirements:

- The rack shall comply with State Building Codes for the seismic area where installed.
- Rack shall be [84"] in height and shall be self-supporting. Base footprint shall be no smaller than 15” x 20”.
- Channel Upright spacing: Per EIA/ECA-310 to accommodate Industry standard 19” mounting.
- Channel Uprights 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).

Construction:

Material: Aluminum

Finish: [Powder coated or painted surface]

Color: [Black]

Rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc.

Vertical hole spacing shall be as follows:

Front - Per EIA/ECA-310 (5/8"-5/8"-1/2")

Rear – 3-inch intervals to accept cable brackets

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 jumpers from the patch panels to the customer provided network equipment.

Hardware shall provide for cable routing on front and rear of each rack.

Vertical managers shall:

- Have non-metallic fingers spaced no greater than and aligned with each Rack Unit indicator on the equipment rack.
- Be equipped with hinged front and rear doors that cover the cable routing area.

Channel dimensions: Minimum width: 8” at end-of-row, 10’ between adjacent racks or as shown on project drawings.

Hardware shall be designed to mount on spacers attached to the rack uprights and not on the upright itself.

- Where multiple racks are to be installed, mount hardware between the uprights of adjacent racks.
- Secure rack uprights and spacers together per manufacturer recommendations.
CABLE RUNWAY
Sometimes referred to as “Ladder Rack”, Cable Runway is used for support and routing of cabling within a Telecommunications Equipment Room.

Construction: Rungs welded to tubular stringers.

Material: 0.065 inch thick steel
Stringer Height - 1.5 inches
Rung Spacing - 9 inches on center

Finish: Manufacturer’s standard epoxy paint or baked-polyester powder coat.

Color: Black

Width: As shown on drawings.

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. A pre-installation meeting will be required on-site prior to working in both new and existing TR's. This also applies to cable runways and ladder racks.

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 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 (FREE STANDING)**

Refer to the Project Drawings for Quantities by location.

Bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. Rack shall also be stabilized by extending a brace extending to the wall. Alternately, overhead cable runway ("ladder rack") over which the cabling accesses the equipment rack(s) shall provide this function.

Use Paint Piercing Washers and screws per manufacturer’s recommendations to ensure that all elements of the rack assembly are electrically common. Apply antioxidant paste to surfaces with which Paint Piercing Washers will come into contact per manufacturer's recommendations.

Position rack to provide minimum clearances as follows:
- ~4" between the rack upright and the wall to allow for cabling in that area.
- 40" from the rear of the rack upright to the wall behind the rack to allow for access by maintenance personnel.
- 40" workspace in front of the rack.
- 72" of clearance is required from the front of the rack upright to the nearest wall/obstruction. This would be the same as sitting a 36" deep 4-post rack with 36" rear clearance.

Locations where these guidelines cannot be followed should be brought to the attention of the Engineer for resolution prior to installation.

Mount all hardware and equipment between 18" and 79" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware should be reviewed and approved by the Engineer and DFD Construction Representative prior to installation.

Provide cable management hardware on both the front and back of rack(s) to allow an orderly and secure routing of cabling.

Provide horizontal cable management hardware per specification Section 27 10 00.

Vertical jumper management shall be double-sided and be 6" wide (minimum). Vertical Jumper Management hardware shall mount on spacers attached to the rack uprights and not on the upright itself. Where multiple racks are to be installed, this hardware shall be mounted between the uprights of adjacent racks. Rack uprights and the spacers shall be secured together per manufacturer recommendations.

Supply each rack with a minimum of twelve (12) releasable (e.g. "hook & loop") cable support ties.

Where Cable Termination Hardware is wall mounted, establish a cable pathway for jumpers routed from the Equipment Rack(s) to the wall. This shall be in the form of slotted ducts, troughs, rings or other means. Routing of jumpers via the overhead ladder rack system is not acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Engineer prior to installation.

**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.

Brace to racks with support brackets made by runway or rack manufacturer intended for this purpose.

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

Support per manufacturers recommendations. Maximum allowable deviation of runway from level horizontal plane measured across length of cable runway shall be 1/2 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.

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. Paint should be removed from the rack at the connection point and the mounting screws should be of the thread-forming type.

Position Electrostatic Discharge (ESD) Kit on (1) rack in each row.

Cable Runway

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

Bond each segment to Telecom Grounding Busbar in room.

END OF SECTION
SECTION 27 10 00
STRUCTURED CABLES
BASED ON DFD MASTER COMMUNICATION SPEC DATED 11/07/16

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.

Included are the following topics:

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

PART 2 - PRODUCTS
Backbone Twisted-Pair Copper Cable
Building Entrance Terminal
Backbone Fiber Optic Cable
Horizontal Permanent Link
Horizontal Twisted-Pair Cable
Fiber Optic Splice Hardware
Equipment Outlet
Modular Patch Panel
Horizontal Jumper Management
Termination Blocks
Fiber Optic termination Enclosure
Flexible Nonmetallic Innerduct and Fittings
Surface Raceway
Miscellaneous Materials

PART 3 - EXECUTION
General
Salvage Materials
Backbone Cable System Topology and Cable Size Requirements
Cable Installation
Building Entrance Terminal
Equipment Outlet
Innerduct
Cable Termination
Identification and Labeling
Testing and Acceptance
Documentation
As-Built Construction Drawings
Warranty
Campus Outside Plant Documentation Update
Construction Verification

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 00 – Common Work Results For Electrical
Section 26 05 26 – Grounding and Bonding for Electrical Systems
Section 26 05 29 – Hangers and Supports for Electrical 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
- SPS Chapter 316 – Wisconsin Dept. of Safety and Professional Services Electrical Code
Structured Cabling and Infrastructure
- ANSI/TIA-862-B – Structured Cabling Infrastructure Standard for Intelligent Building Systems
- ICEA publication S-80-576-2002
- ANSI/TIA-526-14-C and -526-7
- 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.

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 security device connector)
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.
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.

Bidder 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.

Mockups
Build mockups for Floor-box and/or Poke Through Assembly as applicable to verify selections made under Sample submittals, to demonstrate configuration, capacity and aesthetics and to set quality standards for fabrication and installation.

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

- Shop Drawings
- Schedule of Values
- Bidder Qualifications

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

Submittals shall be original catalog sheets, photocopies, or electronic format (ADOBE Portable Document format “.pdf”) thereof. Facsimile (fax) sheets shall not be accepted.

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.

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.

Additional submittals (Test Plan, Test Results, Documentation, Record Documents, etc.) required during and in follow-up to construction 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.

Schedule of Values Submittal
Include in the breakdown of the proposed values for work to be performed-as submitted to the DFD Construction Representative:
• Materials (Line-Item per Class of Material – Horizontal Cable, Backbone Cable, Connectivity, Equipment Racks, etc.)
• Labor – Mobilization
• Labor - Installation
• Labor - Testing
• Labor - Documentation
• Labor - Training
• Additional categories as appropriate

Bidder Qualifications
Upon request, furnish project experience and certification documentation list as identified under “Quality Assurance / Bidder Qualifications” above.
Certification documents confirming contractor status as an active participant in Installers Program operated by Manufacturer of Cabling or Termination Components used shall be from the manufacturer.
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.

PART 2 - 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 cross-talk. (2) 4-Pair cables will be used for the backbone installation in lieu of multi-paired cables.
Cable pair count shall be as detailed on the Project Drawings.

Inter-Building Backbone Twisted-Pair Copper Cable
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.

Cable transmission performance shall meet TIA Category 6A F/UTP criteria.

**Intra-Building Backbone Twisted-Pair Copper Cable**

Cable shall meet or exceed NEC Article 800 Type 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 6 criteria.

**BUILDING ENTRANCE TERMINAL**

Building Entrance Terminal (BET) shall incorporate Gas Tube type devices containing a two element, wide-gap gas tube providing a 265-425 VDC breakdown for lightning/over voltage protection and have a fail-safe design to protect personnel and equipment from exposure to sustained high voltages or currents. BET shall be equipped with such devices for all pairs terminated on the BET.

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

Terminal Blocks on the BET shall be the same type as used for termination of new cabling in the Equipment Room and Telecommunication Room(s).

BET shall be supplied with a grounding lug that will accept a #6 AWG ground wire.

**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.

**Indoor Type Fiber Optic Cable**

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

Cable shall be a Tight Buffer design.

Cable shall be rated: OFNP (Optical Fiber Non-Conductive Plenum)

Outer Sheath: As required for rating

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

**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

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.

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

ISO/IEC type OS2
Fiber shall be meet requirements of TIA-492CAAB Detail Specification for Class IVa

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)

<table>
<thead>
<tr>
<th></th>
<th>Intra-Building (ISP)</th>
<th>Inter-Building (OSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>@ 1310 nm</td>
<td>1.0</td>
<td>0.65</td>
</tr>
<tr>
<td>@ 1550 nm</td>
<td>1.0</td>
<td>0.65</td>
</tr>
</tbody>
</table>

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

HORIZONTAL PERMANENT LINK

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.
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, 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.

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 for Power Sum Attenuation-to-Crosstalk Ratio (PSACR). 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. PSACR shall remain positive at all frequencies up to and including 250-MHz.

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

Project Requirements

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

- Cable Rating: CMP or approved substitutes as defined by the NEC. CATV equivalents apply for coaxial cable where specified.

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

  - Workstation Link (to Equipment Outlet)
    - Performance: Exceed Category 6
    - Cable type: 4-pair UTP
    - Cable Jacket Color:
      - Data: Blue
      - Voice: Blue
    - Modular Jack Pinning and Color:
      - Data [T568B]: Color Orange
      - Voice [T568B]: Color Ivory
  
  - Wireless Access Point Location
    - Performance: [Exceed Category 6]
    - Cable type: [4-pair UTP]
    - Cable Jacket Color: Purple
Modular Jack Pinning and Color
[T568B]; Color Purple
Terminate in 8P8C Modular [Jack]

• Security Device Location
Performance [Exceed Category 6]
Cable type [4-pair UTP]
Cable Jacket Color Yellow
Modular Jack Pinning and Color
[T568B]; Color Yellow
Terminate in 8P8C Modular [Jack]

• Inter-Building Copper Connection - Underground
Performance [Category 6A – F/UTP]
Cable type [4-pair F/UTP] – Fully Water-Blocked With Flood Core
Cable Jacket Color Black
Modular Jack Pinning and Color
[T568B]; Color Black
Terminate in 8P8C Modular [Jack]

HORIZONTAL TWISTED-PAIR CABLE
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 or 23-AWG (Category 6) - 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)

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.

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

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

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

EQUIPMENT OUTLET

General
Station 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]. 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 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.

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

- A minimum of four (4) Modular Jacks when installed on a wall-mounted assembly.
- A minimum of two (2) Modular Jacks 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: [Angled]
- Furniture-Mount-[Angled]
- Floor Box or Poke-Through Assembly: Angled

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]

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.

The dust cover shall be designed to remain 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.
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”.

MODULAR PATCH PANEL

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

Jack color is not applicable unless noted otherwise.

Modular Patch Panel shall be [rack-mounted]

Rack-mounted panel shall be [Angled].

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 shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12-jacks.

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 from the patch panels to the customer provided network equipment.

Horizontal Jumper management hardware shall be:

- A 2 RU (3.5"), painted steel panel.
- Configured with a minimum of five (5) Jumper distribution rings (1.75" x 3.75" minimum dimension).
- Configured with a cover.

TERMINATION BLOCKS

General
Blocks shall be Modular 110/RJ45 type. (Example: Siemon S110AB5-x00JP and S110DB5-xxRJP)

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:

- Backbone Cabling: Category 6 - 4 Pair - 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

Fiber Optic Connector
The Optical Connector shall be [LC] type.

The connector ferrule shall be ceramic or glass-in-ceramic. The optical fiber within the connector ferrule shall be secured with an adhesive or mechanical process 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 DFDM projects. Acceptable means for mating the cabled fiber with the fiber stub include the fusion splice method.

Cable termination method(s) shall be as follows:

- Intra-building (ISP) Backbone – Fusion splicing of factory-terminated cable assemblies (e.g. “pigtails”) to the installed cable.

The Connector Body shall be a Composite material.
Exception: Connector body of ST-type connectors (if applicable) may be metal.

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

- 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).

Connector End-Face finish:

- Single-mode Ultra Physical Contact; UPC

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

- Single-mode (SPC or UPC) – Blue

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

- Single-mode (UPC) -40 dB

Enclosure and Adapter Panels

All terminated fibers shall be mated to [Duplex LC] 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.

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

- Single-mode (UPC) – Blue

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.

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.

**FLEXIBLE NONMETALLIC INNERDUCT AND FITTINGS**

**General**

Flexible Non-metallic Innerduct (e.g. “Innerduct”) may be used as follows:

- As protection to backbone fiber optic cables when installed in cable tray, and/or
- As protection to fiber optic cable(s) within equipment rooms and Telecommunications Rooms.

Innerduct shall be corrugated.

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

Any vacant innerduct shall be equipped with a pull cord and capped at all 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.
MISCELLANEOUS MATERIALS

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

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

Security Fastener Tool
Provide five (5) sets of the tool(s) required to operate the security fastener type used on Equipment Outlet faceplates in secure areas. These tools shall be new and unused.

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.

The contractor will be responsible for identifying and reporting 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 FP&M CP&D 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.

All cables, termination components and support hardware shall be furnished, installed, tested and documented by the Contractor unless noted otherwise.

BACKBONE CABLE SYSTEM TOPOLOGY AND CABLE SIZE REQUIREMENTS
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 the installation environment through which it passes. General Purpose or Riser-rated installed in a Plenum area shall be in conduit.

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.

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. Any cable bent or kinked to radius less than recommended dimension shall not be installed. If any installed cable is kinked to a radius less than recommended dimension it shall be replaced by the contractor with no additional cost to the project.

All wiring shall be run "free-air", in conduit, in a secured metal raceway 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, 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.

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

Protection of cable from foreign materials:

Provide adequate physical protection during construction to prevent foreign material application or contact with any cable type.

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 or cable termination component will not be accepted.

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

It shall be the Contractor’s responsibility to replace any component in its entirety 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.

**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. Multiple cables may share a common enclosure. Slack required in the various subsystems is as follows:

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. Cable slack installed other than at each end of cable run shall not be allowed.

Backbone Fiber Optic Cable [shall 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).

**Horizontal (Station) 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 station cable drop length for Data and Voice UTP (Category 6) shall not exceed 295-feet (90-meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination.

The Contractor is responsible for installing station cabling in a fashion as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Engineer prior to installation.

Changes to the plan shall be approved by the Engineer.

There is no restriction on the length of Category 3 voice cabling within a building (if applicable).

Where installed free-air, installation shall consider the following:

Cable shall run at right angles and be kept clear of other trades work.

Support cables according to code utilizing "J-Hook" or "Bridle Ring" 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. If cable "sag" at mid-span exceeds 6-inches, another support shall be used.

Do not place cable directly on the ceiling grid or attach cable in any manner to the ceiling grid wires. Additionally, when installed in drop or drywall ceilings, the mud ring shall be flush with the finished side of ceiling. When installed in exposed ceilings, the mud ring shall be at least as low as other ceiling mounted objects (e.g: baffles, ducts, lights, etc....)

Do not attach cables to existing cabling, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.

Care should be taken in the use of cable ties to secure and anchor the station cabling. Ties should not be over tightened 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.

Place a coil of 4 feet in each cable shall in the ceiling at the last support (e.g. J-Hook, Bridle Ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each station 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 before the cable leaves the ceiling. Minimum coil diameter shall be 8-inches.

At all Telecommunication Rooms (TR), provide approximately 10-feet of slack in each station 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 bends 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 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 telecommunications cables crossing at right angles.
- All openings shall be sleeved and fire stopped per prevailing code and building construction ratings upon completion of cable installation.
Within the equipment room in which Data Cabling is to be 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.

Fit all Connectors (e.g. modular jacks and coaxial type) with a dust cover.

**Station Cabling in Modular Furniture**

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, it is to be assumed 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, it is to be assumed 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. Any discrepancy between the Project Drawing identifying Outlet locations and the markings should be brought to the attention of the DFD Construction Representative.

The EO shall be secured 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 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.

**BUILDING ENTRANCE TERMINAL**

Provide a listed primary protector on all inter-building backbone copper pairs.

Bond Building Entrance Terminals (BET) to an approved ground using a #6 AWG solid copper conductor.

If a special tool is required to open the BET housing, provide (1) tool for each BET location. Turn over as “miscellaneous materials” to DFD Construction Representative at completion of the work.

**EQUIPMENT OUTLET**

**General**

Outlets shall be flush mounted on wall-mounted boxes, in floor-mounted boxes, on Surface Raceway and in modular furniture.

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 Voice & Data Outlet 18-inches
- Outlet for Wall-Mounted Telephone per ADA
Assemble shielded connector per manufacturer’s recommendations to ensure continuity between connector shield and cable shield.

**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 2-gang outlet box mounted on a grid box hanger (a.k.a. “tile bridge”).
- **Exposed Ceilings (surface mount)** - cabling piped out of tray to a 2-gang outlet box.
- **Drywall** - deliver cable into flush mounted 2-gang outlet box.
- **Reduce opening to 1-gang using “mud ring”**.

Provide cable slack at each location to allow for re-location of the EO. Unless noted otherwise on the project drawings, slack length (each cable) shall be 20-feet.

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

**INNERDUCT**

Where required by the project design, install fiber optic cable in protective innerduct.

Innerduct shall be riser or plenum rated as required by the installation environment. At minimum, innerduct should extend to the ladder rack above the termination enclosure at system endpoints.

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

Identify all exposed innerduct is to be labeled at 35-foot (minimum) intervals with tags indicating ownership, the 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.

Extend innerduct into the termination enclosure at system endpoints.

**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 Security device where terminated in a Modular Plug), terminate cabling per manufacturer’s recommendations.

Terminate Plus using pin/pair assignments as identified in the above article “HORIZONTAL PERMANENT LINK”.

**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.

Unless spare capacity is noted on project drawings:

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 consisting of 5/8 inch plywood securely fastened to the building walls. All six surfaces of the plywood must be painted with fire retardant paint.

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 Station Cabling are terminated in separate columns. Position Backbone Cabling to the Left; Station 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 Station 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.
**Cross-connect Wiring or Patching**

The Owner shall be responsible for the “Cross-connect” wiring or patching between Horizontal and Backbone cabling.

The contractor shall not 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 Service Provider cabling. It shall be the responsibility of the Contractor, to work with the Owner and DFD Construction Representative and provide the necessary assistance to allow Owner and/or Telephone Company personnel to make the necessary connections to establish service on the new cable system. These activities include, but are not limited to cross-connect documentation, general wiring overview and cable pair identification.

**Cable Termination - Modular Patch Panels**

Install Modular Patch Panel(s) in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections. Additionally, numbering shall remain sequential by row (left to right) and not be separated by cable type. (UTP or F/UTP).

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

Cables designated for cameras—where applicable—shall be terminated on patch panel shared with other 4-pair horizontal cabling.

Cables designated for WAPS where applicable—shall be terminated on patch panel shared with other 4-pair horizontal cabling.

At Equipment Outlet and Modular Patch Panel, ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for Data cables. The cable jacket shall be removed only to the extent required to make the termination.

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

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. Refer to project drawings.

**Cable Termination - Fiber Optic**

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

Terminate all optical fibers using the specified connector type.

Mate all terminated fibers to couplings mounted on patch panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting 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 Multi-mode and single mode optical fibers (where applicable) on the panels as to clearly identify the distinction between the fiber types.

Install Duplex Couplers (where applicable) 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.

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 of cleaning technique and products.

**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 summary of the proposed test plan for each cable type including equipment to be used, setup, test frequencies or wavelengths, results format, etc. Failure to provide the above information shall be grounds for the Owner/Engineer to reject any and all Documentation of Results on related testing and to require a repeat of the affected test.

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.

Representatives of the Owner 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.

All equipment used in testing shall be maintained and calibrated per manufacturer’s guidelines. Provide documentation of equipment calibration.
Document all tests. Refer to the Article “DOCUMENTATION” below which details requirements.

Perform tests related to connected equipment of others only with the permission and presence of Contractor involved.

All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the contractor. The applicable tests shall then be repeated.

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, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor’s expense.

**Copper Backbone Cabling**

Backbone Voice cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity and conductor position on the termination blocks.

Any mis-positioned pairs shall be corrected.

The percentage of “bad” pairs shall not exceed 3% in any Backbone Cable based on total pair count. All bad pairs must be identified and documented.

**Horizontal 4-pair Copper Cabling**

**General**

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

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 “Station” 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.

Additional testing of Cabling Systems rated at TIA Category 6 and higher shall be performed to confirm proper functioning and performance.

**Performance Testing**

Testing of the Transmission Performance of station cables shall 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

Cables shall be tested to the maximum frequency defined by the standards covering that performance category.
Transmission Performance Testing shall be performed using a test instrument designed for testing to the specified
frequencies. Test records shall verify "PASS" on each cable and display the specified parameters - comparing test
values with standards based "templates" integral to the unit. Test method shall document all parameters specified by
the standard.

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

Where margin(s) over compliance with the identified standard(s) is specified, field verify that the necessary margins are
met and take corrective actions necessary to remedy out-of-spec links.

The maximum length of station cable shall not exceed 90 meters, which allows 10 meters for equipment and patch
cables.

In order to establish testing baselines, cable samples of known length and of the cable type and lot installed shall be
tested. The cable may be terminated with an 8-position Modular plug (8-pin) to facilitate testing. Net Propagation
Velocity (NPV) and nominal attenuation values shall be calculated based on this test and be utilized during the testing
of the installed cable. This requirement can be waived if NPV data is available from the cable manufacturer for the
exact cable type under test.

In the event results of the tests are not satisfactory, make changes as necessary, and shall then repeat the test or tests
which disclosed faulty or defective material, equipment or installation method, and shall make additional tests as the
Engineer deems necessary at no additional expense to the project or user agency.

Special Considerations

Where Cabling is terminated in a Modular Plug at the device location (e.g. Video Surveillance Camera or Wireless
Access Point), use one of the following methods:

- Use Modular-Jack to Modular Jack adapter cord.
- Use tester configured with Channel Test head at "plug end". This method must be supported by the test
equipment manufacturer.

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.

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 Owner, Contractor may perform tests deemed necessary by
the Contractor to ensure integrity of any Owner furnished optical fiber. Tests may range from a simple “flashlight test”
to an OTDR of each optical fiber of each cable reel prior to installation. 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:

Optical Attenuation (“Insertion Loss” Method)
Verification of Link Integrity (OTDR)

Optical Attenuation Testing
Measure Optical Attenuation on all terminated optical fibers in at least one direction of transmission using the “Insertion
Loss” method. Measurement shall be inclusive of the optical connectors and couplings installed at the system
endpoints. Access Jumper length (each end) shall be 1 to 5 meters (3.3 to 16.4 ft).

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 of optical fibers (all fiber types) shall not exceed the values calculated per TIA-5680.D.

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 dB
Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers) and F is
the maximum allowable fiber loss (in dB/km). S is the total splice loss (# of splices * max. attenuation per
splice).

OTDR Testing
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 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 of the entire length of the cable,
including the connectors at the launch and tail end.

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.
DOCUMENTATION

General

Upon completion of the installation, provide project documentation to the Engineer for review. Documentation shall include the items detailed in the sub-sections below. Provide approved test results and documentation in Operating and Maintenance Manuals.

Submit documentation of Test Results in electronic form for review and distribution.

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 a MICROSOFT Windows-based personal computer supplied by the Owner. Software shall include license if applicable.

Organize documentation by Building and Telecom Room.

Provide final documentation on CD-ROM. Interim documentation may be submitted to the Engineer for review via email, FTP, CD-ROM or other electronic means.

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.

Submit Documentation within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.).

Interim documentation on a shorter schedule will be required to accommodate occupancy or other requirements. Confirm requirements during construction.

When such interim documentation is submitted, submit a composite results package containing all records at closeout.

This is inclusive of all test result and draft as-built drawings. Draft drawings may include annotations done by hand.

Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.

The Engineer may request that a 10% random field re-test be conducted on the cable system at no additional cost 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. This re-test shall be at no additional cost to the Owner.

Test Data - Copper Media

Test results shall include a record of test frequencies, cable type, conductor pair and cable I.D., 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 a graphical display of key test parameters. 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) are not required.
Cross-Connect Data
Provide the necessary assistance to allow Owner and/or Telephone Service Provider personnel to make the necessary connections to establish telephone 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, and the “High” and “low” values.
  The Summary shall be in Adobe Acrobat (.pdf) format and include all records.

Submit OTDR in electronic form as follows

- In the native format of the test instrument.
- Plots of individual optical fiber “signatures” (traces). Combine plots for all fibers in a cable into a single Adobe Acrobat (.pdf) file.

AS-BUILT CONSTRUCTION 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.

The Division of Facilities Development - through the Consultant - will provide floor plans in paper and electronic (AutoCAD .dwg) formats on which as-built construction information can be added. These documents will be modified accordingly by the contractor to denote as-built information as defined above and returned to the Consultant for acceptance. The schedule for creation of these drawings, including interim and final sets, shall be coordinated during construction to accommodate scheduled occupancy of documented area(s).

Annotate the base drawings and return to the A/E in hard copy (same plot size as originals) and electronic (AutoCAD .dwg; 2014 file format) form. Refer to DFD “Policy and Procedure Manual for Architects/Engineers And Consultants” for file format, naming and other applicable guidelines.

Identify each drawing submitted by the Contractor as part of the Project Documentation as an "As-built" drawing 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 file and test plot to the Engineer for review and approval.

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

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

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 warrant. Cabling and Connecting Components shall carry a 15 year manufacturer’s component warranty.

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.

Provide Warranty Certification of the Horizontal Copper Permanent Link by the manufacturer(s) of cabling and connecting components as part of system documentation.

Submit documents to manufacturer as required for Extended Warranties.

CAMPUS OUTSIDE PLANT DOCUMENTATION UPDATE

Provide documentation to allow the campus to update existing drawings and data tables to include signal conduits, maintenance holes, and communication cabling added by this project.

Records can be obtained from the campus or from the DFD.

CONSTRUCTION VERIFICATION

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 27 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION
SECTION 27 08 00
COMMISSIONING OF COMMUNICATIONS

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 Forms
CV-27 05 53 Identification for Communications Systems
CV-27 10 00 Structured Cabling
CV-27 11 00 Communications Equipment Room Fittings
CV-27 16 19 Communications Patch Cords, Station Cords, and Cross-Connect Wire

RELATED WORK
Section 01 91 01 – Commissioning Process

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.
SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS
BASED ON DSF MASTER COMMUNICATION SPEC DATED 11/07/16

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
General
Equipment Room and Fittings
Pathways
Cable and Termination Hardware
Miscellaneous
PART 3 - EXECUTION
General
Equipment Room and Fittings
Pathways
Horizontal Cable and Termination Hardware
Backbone Cable – Copper and Fiber Optic
Termination Blocks
Fiber Optic Patch Panels
Abandoned Cable

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, are covered in the respective Division 26 and/or 27 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.

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.

EQUIPMENT ROOM AND FITTINGS
Backboard
Adhesive Label or Stencil.

Character height shall be 2-inch (minimum).

Equipment Racks and Cabinets
Adhesive Label.

Character height shall be 1-inch (minimum).

Equipment Enclosures
Adhesive Label.

Character height shall be 1-inch (minimum).

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 White Vinyl or other appropriate substrate and incorporate a clear lamination that, when label is wrapped around cable, covers printed part of label. Flag type labels are not allowed.

Labels shall be 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.

MISCELLANEOUS
None

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.

EQUIPMENT ROOM AND FITTINGS

General

Designators for communications equipment rooms shall be as follows:

- New Welcome Center
- New TR Room #0437
- Existing Central Lodge
- Existing Conference Room #0245

Telecommunication Room identifiers shall be unique in each building.

Site Name Name = (AAA)
  A = State of Wisconsin Site ID

Building Name or ID = (“I”)
  B = Building ID on Campus

Rack Number or Cabinet Number = (DD)
  D = Rack Number Within a specific TR

Patch Panel Number or ID = (EE)
  E = Patch Panel within a specific Rack #

Cable ID = (FFF)
  F = The actual number of the cable in order from first to last patch panel in a single TR.
  (Example: AAA-B-CC-DD-EE-FFF)

PATHWAYS

Innerduct

Label exposed innerduct containing fiber optic cable. This includes areas where the innerduct is (1) Installed in risers, tunnels or trays, (2) in each maintenance hole, hand hole and pull box and (3) in equipment rooms. Space labels at 25-foot intervals (maximum) in a tunnel or cable tray installation. Adjust labeling interval to insure that tags are visible.

Mark Label with:
- Fiber Count
- Cable Designation as defined for Backbone Cables.

Hand lettering is acceptable on this tag, using an indelible type ink.

Secure the tag to the innerduct(s) using self-locking ties.

HORIZONTAL CABLE AND TERMINATION HARDWARE

General

Label all Equipment Outlets, Patch Panels, Termination Blocks, and Cables.

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

Equipment Outlet identification shall be based on - or result in – a logical numbering sequence in each Work Area.

Labeling plans that results in random EO numbering are not acceptable.

Label Equipment Outlets on the faceplate and, if applicable, on the base or frame of the EO which is permanently attached to its mounting.

Where outlet faceplates incorporate recessed label holders, labels shall be positioned beneath clear plastic covers that are part of the faceplate assembly. Where no such label holders are present (e.g. on existing to remain outlets or wall-mounted telephone-only outlets) protect the faceplate labels with a clear over-laminate.
Labels shall be White background with Black lettering. Lettering size shall be as large as practicable (up to 16-point) to fit properly on the outlet label. No lettering shall be smaller than 12-point.

Where there is a distinction between “Voice” and “Data”, number each media type separately. Where there is no distinction between horizontal cabling that may be used for “Voice”, “Data”, “CATV”, “IPTV”, etc., number the media types sequentially.

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

HC-PP-##

where: HC = Identifier for Horizontal Cross-connect serving that location
PP = Designation for the Patch Panel on which cable is terminated at the HC; a number starting at “01”. Panels are to be numbered be from Top (of Rack) to Bottom.
## = Sequential position of the Jack on the Panel; A numerical value of 01 - 48 is typical starting at the top left and counting from Left-to-Right.

For example: “1E-03-25” represents a cable terminated in the 25th Jack Position in Patch Panel “3” at the Horizontal Cross-connect identified as “1E”.

Faceplate labels can use common HC identifiers on each label strip. For example, two links that terminate in the room designated as “TR1E” on positions “47” and “48” of Patch Panel “01” located on Rack “A” and sharing common label strip may be represented by:

```
1E
01-47
01-48
```

Horizontal Cable
Code used to label Horizontal Cables shall be same as identified for Equipment Outlet above.
Label each Horizontal Cable at the Horizontal Cross-connect (e.g. Modular Patch Panel or Termination Block) and at the Equipment Outlet. If applicable, label cables at an intermediate interconnect such as a Consolidation Point in a Zone Cabling installation.

At an Equipment Outlet or Modular Patch Panel, position labels within 4-inches of each cable end.
At a Termination Block, position label so that it is not obscured by the designation strip (labeling) on the block.

Modular Patch Panels
Label each Patch Panel and port at horizontal cross-connect with unique identifying code. Code shall identify Outlet ID that corresponds with each jack/connector position.

Horizontal Cross-connect (location) identifier is not required on modular patch panels.
Modular Patch Panel labeling format shall be as follows:

Patch Panel labeling format shall be same as identified for Equipment Outlet above. Connectors shall be positioned in sequence of Outlet ID.

BACKBONE CABLE – COPPER AND FIBER OPTIC
General
Label backbone (inter- and intra-building, and tie) cables at both ends with a unique code.

Code shall identify where cable originates and where the opposite end of the same cable terminates (e.g. “far end” cross-connect location at ER, HC, etc.).

Fiber type designations for fiber optic cable shall be as follows:
• Single-mode OS2
Copper type designations for copper cable shall be as follows:
• 4 – Pair Category Six Cat.6

Backbone Cabling - Intra-Building & Tie
Label Intra-Building (within building) and Tie cabling with:
• Origin and Destination locations (e.g. “From & To”)
• Fiber type(s) (Fiber Optic Cable only)
• Pair Count or Fiber Count

Example: Label for 200-pair copper cable installed from Main Cross-connect to Telecom Room 1E (TR1E) would appear as follows:

```
MC-TR1E
001-200
```

Example: Label for fiber optic cable containing (24) 50/125µm, LASER-optimized multimode fibers installed from Main Cross-connect to Telecom Room 1E (TR1E) would appear as follows:

```
MC-TR1E
24-LOMMF
```

Where multiple cables are installed between same end-points, labeling shall indicate sequential pair numbering. For example, 200-pair provided as two 100-pair cables would be labeled “001-100” and “101-200”.

**Backbone Cabling - Inter-Building**

Label Inter-Building (between buildings) cabling with:

• Origin and Destination locations (e.g. “From & “To”)
• Fiber type(s) (Fiber Optic Cable only)
• Pair Count or Fiber Count
• Date Installed

Example: Label for 300-pair cable installed October 2012 from Building 123 Main Cross-connect (MC123) to Building 456 Main Cross-connect (MC456) would appear as follows:

```
MC123 – MC456
001-300
10/2012
```

Example: Label for fiber optic cable containing (24) 50/125µm, LASER-optimized multimode fibers and (12) Single-mode fibers installed October 2012 from Building 123 Main Cross-connect (MC123) to Building 456 Main Cross-connect (MC456) would appear as follows:

```
MC123-MC456
24-LOMMF
12-SMF
10/2012
```

• Where multiple cables are installed between same end-points, labeling shall indicate sequential pair numbering. For example, 600-pair provided as two 300-pair cables would be labeled “001-300” and “301-600”.

**TERMINATION BLOCKS**

**General**

Provide color-coded Designation Strips with Termination Blocks.

Label termination positions on Designation Strips with identifier.

Label each Designation Strip with (2) rows of identifiers. Identifiers on “upper” row on each strip refer to cable positions ABOVE the label; identifiers on the “lower” row refer to cable positions BELOW the label.

**Horizontal Cabling**

Designation Strips for Blocks on which Horizontal Cabling is terminated shall be BLUE.

Code used to label Designation Strips shall be same as identified for Equipment Outlet above. Label each position.

Horizontal Cross-connect (location) identifier is not required on Termination Blocks.
Example: Designation Strip for block on which “Voice” cables 001V – 012V are terminated would appear as follows:

- - - - - Conductors Positions - - - - -

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<thead>
<tr>
<th>001V</th>
<th>002V</th>
<th>003V</th>
<th>004V</th>
<th>005V</th>
<th>006V</th>
</tr>
</thead>
<tbody>
<tr>
<td>007V</td>
<td>008V</td>
<td>009V</td>
<td>010V</td>
<td>011V</td>
<td>012V</td>
</tr>
</tbody>
</table>

Backbone Cabling - Intra-Building
Designation Strips for Blocks on which Intra-Building (within building) Backbone Cabling is terminated shall be WHITE.

Label Designation Strips with:
- Cable Origin & Destination. Repeat on every designation strip.
- Pair Number. Label 1st and 25th Positions on each row (e.g. 001 & 025, 026 & 050, etc.).

Example: Designation Strip for block on which pairs 001 – 050 in cable linking Main Cross Connect with Horizontal Cross-connect at TR1E would appear as follows:

- - - - - Conductors Positions - - - - -

<table>
<thead>
<tr>
<th>001</th>
<th>MC – TR1E</th>
<th>025</th>
</tr>
</thead>
<tbody>
<tr>
<td>026</td>
<td>050</td>
<td></td>
</tr>
</tbody>
</table>

Backbone Cabling - Inter-Building
Designation Strips for Blocks on which Inter-Building (between buildings) cabling is terminated shall be BROWN.

Label Designation Strips with:
- Cable Origin & Destination. Repeat on every designation strip.
- Pair Number. Label 1st and 25th Positions on each row (e.g. 001 and 025, 026 and 050, etc.).

Example: Designation Strip for block on which pairs 001 – 050 in cable linking Building 123 Main Cross-Connect (MC) and Bldg. 456 Main Cross-connect are terminated would appear as follows:

- - - - - Conductors Positions - - - - -

<table>
<thead>
<tr>
<th>001</th>
<th>123MC – 456MC</th>
<th>025</th>
</tr>
</thead>
<tbody>
<tr>
<td>026</td>
<td>050</td>
<td></td>
</tr>
</tbody>
</table>

Voice Multiplier
The following assumes creation of a Voice “Multiplier” Block using 100-pair blocks which have been wired to make each pair position in a row common with the comparable position in each other row.

Designation Strips for Voice Multiplier Blocks shall be YELLOW.

Label Designation Strips with:
- Designation as “MULTIPLIER”. Repeat on every designation strip.
- Row designator - Label 25-pair rows in 100-pair multiplier block as "A" (1st 25-pair), "B" (2nd 25-pair), "C" and "D".
- Pair Number. Label 1st and 25th Positions on each row (e.g. 001 and 025).
Example: Designation strips (2) for 25-pair multiplier (4 x 25 pair = 100-pair block) would appear as follows:

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

<table>
<thead>
<tr>
<th>A001</th>
<th>MULTIPLIER</th>
<th>A025</th>
</tr>
</thead>
<tbody>
<tr>
<td>B001</td>
<td></td>
<td>B025</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>C001</th>
<th>MULTIPLIER</th>
<th>C025</th>
</tr>
</thead>
<tbody>
<tr>
<td>D001</td>
<td></td>
<td>D025</td>
</tr>
</tbody>
</table>

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

**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 - - - - -

<table>
<thead>
<tr>
<th>1001</th>
<th>NETWORK (AT&amp;T)</th>
<th>1025</th>
</tr>
</thead>
<tbody>
<tr>
<td>1026</td>
<td></td>
<td>1050</td>
</tr>
</tbody>
</table>

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

**Telephone System Equipment Cabling**

Designation Strips for Blocks on which cabling from Telephone System Equipment is terminated shall be PURPLE.

Label Designation Strips with:
- Equipment Designation (e.g. System or Equipment Type)
- Pair Number.

Example: Designation strip for block on which pairs 001 - 050 from PBX is terminated would appear as follows:

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

<table>
<thead>
<tr>
<th>001</th>
<th>PBX</th>
<th>025</th>
</tr>
</thead>
<tbody>
<tr>
<td>026</td>
<td></td>
<td>050</td>
</tr>
</tbody>
</table>

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

**FIBER OPTIC PATCH PANELS**

Label front of each Fiber Optic Patch Panel with unique labeling codes to identify:
- [Cable Destination] [Cable Number] [Patch panel number in rack]
- Fiber type(s)
- Label each fiber (or coupler) position number of each panel position.
- Fiber/coupler I.D. shall be from Top to Bottom, Left to Right,
- Manufacturers port labeling is acceptable.

Room designator is not required on fiber optic patch panels.

Equipment Rack designator is not required on fiber optic patch panels.

**ABANDONED CABLE**

Not applicable to this Project. No labeling required.