GENERAL SPECIFICATIONS

For

EASTERN MICHIGAN UNIVERSITY

(EMU)

Eastern Michigan University Campus

Technology Infrastructure Specifications
## TABLE OF CONTENTS

**DIVISION 27 – TELECOMMUNICATIONS**

<table>
<thead>
<tr>
<th>Tab</th>
<th>Section</th>
<th>Description</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>27000</td>
<td>Telecommunications General</td>
<td>27000-1 to 12</td>
</tr>
<tr>
<td>II</td>
<td>27050</td>
<td>Basic Telecommunications Materials &amp; Methods</td>
<td>27050-1 to 12</td>
</tr>
<tr>
<td>III</td>
<td>27060</td>
<td>Underground Raceways &amp; Structures</td>
<td>27060-1 to 09</td>
</tr>
<tr>
<td>IV</td>
<td>27110</td>
<td>Telecommunications Equipment Room</td>
<td>27110-1 to 09</td>
</tr>
<tr>
<td></td>
<td>SK-1</td>
<td>Typical 10’ x 15’ Equipment Room</td>
<td>SK-1</td>
</tr>
<tr>
<td>V</td>
<td>27130</td>
<td>Backbone Cabling</td>
<td>27130-1 to 11</td>
</tr>
<tr>
<td>VI</td>
<td>27150</td>
<td>Horizontal Cabling</td>
<td>27150-1 to 09</td>
</tr>
<tr>
<td></td>
<td>SK-2</td>
<td>EMU Hierarchical Star Topology Diagram</td>
<td>SK-2</td>
</tr>
<tr>
<td></td>
<td>SK-3</td>
<td>Typical Telecommunication Room</td>
<td>SK-3</td>
</tr>
<tr>
<td>VII</td>
<td>27160</td>
<td>Work Area (Connecting Cords and Devices)</td>
<td>27160-1 to 04</td>
</tr>
<tr>
<td>VIII</td>
<td>27170</td>
<td>Telecommunications Administration</td>
<td>27170-1 to 03</td>
</tr>
<tr>
<td></td>
<td>SK-4</td>
<td>Work Area &amp; Patch Panel Labeling Diagram</td>
<td>SK-4</td>
</tr>
<tr>
<td>IX</td>
<td>27190</td>
<td>Additional Information</td>
<td>27190-1 to 03</td>
</tr>
</tbody>
</table>
SECTION 27000 – TELECOMMUNICATIONS GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General, and Supplementary Conditions and Division 1 Specifications, apply to this document.

1.2 SUMMARY

Eastern Michigan University (EMU) is a comprehensive university founded by the Michigan State Legislature in 1849 and presently the fifth largest university in Michigan with approximately 24,000 students. As with any other university in today’s highly technological world, EMU must move forward in parallel with the telecommunications industry. A sound, structured cabling system is imperative to support voice, data and video services in this regard. Therefore, it is the intent of this document to provide specific technical specifications resulting in a standard level of quality throughout the campus. This standardization will involve the review and adoption of existing and emerging industry standards resulting in an efficient telecommunications infrastructure for EMU in the long term.

A. Provide all equipment, materials, labor, and services, not specifically mentioned or shown, which may be necessary to complete or perfect all parts of the installation. Ensure that they are in compliance with requirements stated or reasonably inferred by the contract documents.

1.3 DEFINITIONS

A. ANSI: American National Standards Institute
B. BICSI: Building Industry Consulting Service International
C. EIA: Electronic Industries Alliance
D. NEC: National Electrical Code
E. RCDD: Registered Communications Distribution Designer
F. TIA: Telecommunications Industry Association
G. HC: Horizontal Cross-Connect (Floor Distributor)
H. IC: Intermediate Cross-Connect (Building Distributor)
I. MC: Main Cross-Connect (Campus Distributor)
J. **Owner:** The term Owner as used in these specifications refers to Eastern Michigan University; Board of Regents, Ypsilanti, Michigan.

K. **Owners Representative:** The term Owners Representative as used in these specifications refers to the EMU ICT Division on all matters related to the technical aspect of data transmission, data equipment, cabling, and installation of same. The term Owners Representative also refers to EMU Physical Plant for matters related to building construction and/or construction contract management.

L. **Engineer/Designer:** The term Engineer/Designer as used in these specifications refers to the EMU – ICT Network Engineering and Consultant/Engineer, if applicable.

M. **Contractor:** The term Contractor as used in these specifications refers to the organization that shall furnish all the labor, materials, equipment, services, and supervision to perform all the work shown on the drawings and specifications.

1.4 **REFERENCES**

The following industry standards are the basis for the structured cabling system described in this document.

1.4.1 **ANSI/TIA/EIA**

- **ANSI/TIA/EIA-568-B.2** Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components
- **ANSI/TIA/EIA-568-B.3** Optical Fiber Cabling Components Standard
- **ANSI/TIA/EIA-569-A** Commercial Building Standard for Telecommunications Pathways and Spaces
- **ANSI/TIA/EIA-606** The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- **ANSI/TIA/EIA-607** Commercial Building Grounding and Bonding Requirements for Telecommunications
- **ANSI/TIA/EIA-526-7** Measurement of Optical Power Loss of Installed Single Mode Fiber Cable Plant
• ANSI/TIA/EIA-526-14A Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant

• ANSI/TIA/EIA-758(A) Customer Owned Outside Plant Telecommunications Cabling Standard

1.4.2 BICSI

• BICSI – Telecommunications Distribution Methods Manual
• BICSI – Cabling Installation Manual
• BICSI – LAN Design Manual
• BICSI – Customer-Owned Outside Plant Design Manual

1.4.3 NFPA

• NFPA-70 National Electric Code (NEC)

1.4.4 IEEE

• C2-2002 National Electric Safety Code (NESC)

1.4.5 ISO/IEC

• ISO/IEC 11801 General Cabling for Customer Premises

The most recent versions of the above documents apply to this project.

Federal, state, and local codes, rules, regulations, and ordinances governing the work, are as fully part of the specifications as if herein repeated or hereto attached. If the contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Owners Representative in writing. Where the requirements of other sections of the specifications are more stringent than applicable codes, rules, regulations, and ordinances, the specifications shall apply.

1.5 SUBMITTALS

A. Submit to the engineer/designer shop drawings, product data (including cut sheets and catalog information), and samples required by the contract documents. Submit shop drawings, product data, and samples with such promptness and in such sequence as to cause no delay in the work or in the activities of separate contractors. The engineer/designer will indicate approval of shop drawings, product data, and samples submitted to the engineer/designer by stamping such submittals “APPROVED” with a stamp. Submitted shop drawings shall be initialed or signed by the contractor, showing the date and the contractor’s legitimate firm name.

1) By submitting shop drawings, product data, and samples, the contractor represents that he or she has carefully reviewed and verified materials, quantities, field measurements, and field construction criteria related thereto. It also represents that the contractor has checked, coordinated, and verified that information contained within shop drawings, product data, and samples conform
to the requirements of the work and the contract documents. The engineer/designer remains responsible for the design concept expressed in the contract documents as defined herein.

2) The engineer's/designer's approval of shop drawings, product data, and samples submitted by the contractor shall not relieve the contractor of responsibility for deviations from requirements of the contract documents, unless the contractor has specifically informed the engineer/designer in writing of such deviation at time of submittal, and the engineer/designer has given written approval of the specific deviation. The contractor shall continue to be responsible for deviations from requirements of the contract documents not specifically noted by the contractor in writing, and specifically approved by the engineer/designer in writing.

3) The engineer's/designer's approval of shop drawings, product data, and samples shall not relieve the contractor of responsibility for errors or omissions in such shop drawings, product data, and samples.

4) The engineer's/designer's review and approval, or other appropriate action upon shop drawings, product data, and samples, is for the limited purpose of checking for conformance with information given and design concept expressed in the contract documents. The engineer's/designer's review of such submittals is not conducted for the purpose of determining accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the contractor as required by the contract documents. The review shall not constitute approval of safety precautions or of construction means, methods, techniques, sequences, or procedures. The engineer's/designer's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

B. Perform no portion of the work requiring submittal and review of shop drawings, product data, or samples, until the engineer/designer has approved the respective submittal. Such work shall be in accordance with approved submittals.

C. Submit shop drawings, product data, and samples as a complete set within thirty (30) days of award of contract, unless otherwise specified in the contract documents.

1. For initial submission and for resubmission required for approval, submit six (6) copies of each item. The engineer/designer will only return four copies. Make reproductions as required for your use and distribution to contractors.

2. Illegible submittals will not be checked by the engineer/designer.
D. General: Submit the following:
   1. Bill of materials, noting long lead time items.
   2. Optical loss budget calculations for each optical fiber run.
   3. Project schedule including all major work components that materially
      affect any other work on the project.

E. Shop drawings: Submit the following:
   1. Backbone (riser) diagrams.
   2. System block diagram, indicating interconnection between system
      components and subsystems.
   3. Interface requirements, including connector types and pin-outs, to
      external systems and systems or components not supplied by the
      contractor.
   4. Fabrication drawings for custom-built equipment.

F. Product Data – Provide catalog cut sheets and information for the following:
   1. Wire, cable, and optical fiber.
   2. Outlets, jacks, faceplates, and connectors.
   3. All metallic and nonmetallic raceways, including surface raceways,
      outlet boxes, and fittings.
   4. Terminal blocks and patch panels.
   5. Enclosures, racks, and equipment housings.
   6. Over-voltage protectors
   7. Splice housings

G. Samples
   1. One of each type of outlet.
   2. Six-inch nonmetallic surface raceway, one outlet box, and one
      faceplate in each color.

H. As-Built drawings:
   1. Submit as-built drawings upon acceptance of project completion and
      include:
      a. Approved shop drawings.
      b. Plan drawings indicating locations and identification of work
         area outlets, nodes, telecommunications rooms (TRs), and
         backbone (riser) cable runs.
      c. Telecommunication rooms (TRs) and equipment room (ER
         and/or MC) termination detail sheets.
      d. Cross-connect schedules including entrance point, main cross-
         connects (MC), intermediate cross-connects (IC), and
         horizontal cross-connects (HC).
e. Labeling and administration documentation.
f. Warranty documents for equipment.
g. Copper certification test result printouts and diskettes.
h. Optical fiber power meter/light source test results.

I. Operation and maintenance manuals:

1. Provide three (3) copies of operations and maintenance manuals. As a minimum, manuals should include:
   a. Complete schematics of each system component.
   b. Troubleshooting procedures.
   c. Factory-authorized support information.

1.6 QUALITY ASSURANCE

A. Contractor Qualifications: Cabling installer must have on staff personnel certified by Building Industry Consulting Service International (BICSI) and/or manufacturer certified installer as noted.

1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician or Level 2 Installer, who shall be present at all times when work of this Section is performed at job site.

The contractor shall have worked satisfactorily for a minimum of three (3) years on systems of this type and size.

The contractor must provide at least three (3) references with specific information regarding type of project and involvement in providing of equipment and services.

Subcontractors shall assume all rights and obligations toward the contractor that the contractor assumes toward the Owner, Owners Representative and Engineer/Designer.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by BICSI as an RCDD to supervise field quality-control testing.

C. Source limitations: Obtain all products except cables through one source from a single manufacturer.
D. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70, “National Electrical Code.”


1.7 WARRANTY

A. Unless otherwise specified, unconditionally guarantee in writing the materials, equipment, and workmanship for a period of not less than three (3) years from date of acceptance by the Owner. The Owners Representative shall deem acceptance as beneficial use.

B. Transfer manufacturer’s warranties to the Owner in addition to the General System Guarantee. Submit these warranties on each item in list form with shop drawings. Detail specific parts within equipment that are subject to separate conditional warranty. Warranty proprietary equipment and systems involved in this contract during the guarantee period. Final payment shall not relieve the contractor of these obligations.

C. No warranty or terms therein shall limit or be interpreted to limit remedies as provided by law.

1.8 COORDINATION

A. Coordinate layout and installation of voice and data communication cabling with the Owners telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owners Representative and Engineer/Designer to exchange information and agree on details of equipment arrangements and installation interfaces as requested by the Owner.

2. Prepare meeting minutes noting agreements, decisions, topics discussed, etc. and distribute in a timely manner.

3. Adjust arrangements and locations of distribution frames, cross-connect, patch panels, etc. in equipment rooms and wiring closets to accommodate space requirements of telephone switch and LAN equipment.
1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cable: 250 feet (76m) of each size and type used for Project. Furnish on reels.
2. Patch-Panel Units: One of each type for every 6 installed, but no fewer than one.
3. Fiber-Optic Termination Enclosures: One of each type for every 6 installed, but no fewer than one.
4. Termination Enclosure Modules: One of each type for every 12 installed, but no fewer than one.
5. Connecting Blocks: One of each type for every 25 installed, but no fewer than one.
6. Outlet Assemblies: One of each type for every 25 installed, but no fewer than one.
7. Device Plates: One of each type for every six installed, but no fewer than one.

1.10 DELIVERY, STORAGE, AND HANDLING

Protect equipment during transit, storage, and handling to prevent damage, theft, soiling and misalignment. Coordinate with the Owners Representative for secure storage of equipment and materials. Do not store equipment where conditions fall outside manufacturer’s recommendations for environmental conditions. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment. Notify the Owners Representative immediately of any such event in writing.

1.11 USE OF THE SITE

A. Use of the site shall be at the Owners Representative direction in matters in which the Owner deems it necessary to place restriction.

B. Access to the building wherein the work is performed shall be as directed by the Owners Representative.

C. The premises may be occupied during the entire period of construction for conducting normal business operations. Cooperate with the Owners Representative to minimize conflict and to facilitate its operations.

D. Schedule necessary shutdowns of plant services with the Owners Representative, and obtain written permission. Refer to CONTINUITY OF SERVICES herein.
E. Proceed with the work without interfering with ordinary use of streets, aisles, passages, exits and operations of EMU.

1.12 CONTINUITY OF SERVICES

A. Take no action that will interfere with, or interrupt, existing building services unless previous arrangements have been made with the Owners Representative. Arrange the work to minimize shut down time.

B. The Owners personnel will perform shutdown of operating systems. The contractor shall give three (3) days’ advance notice for systems shutdown.

C. Should services be inadvertently interrupted, immediately furnish labor, including overtime, material, and equipment necessary for prompt restoration of interrupted service.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

Product selection subject to compliance with the Owners standard requirements, provide products by one of the manufacturers specified.

2.2 FABRICATION

Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.

2.3 SUITABILITY

Provide products that are suitable for intended use, including, but not limited to environmental, regulatory, and electrical.

PART 3 – EXECUTION

3.1 INSTALLATION STANDARDS

3.2 PRE-INSTALLATION SITE SURVEY

A. Prior to start of systems installation, meet at the project site with the Owners Representative and representatives of trades performing related work to coordinate efforts. Review areas of potential interference and resolve conflicts before proceeding with the work.

B. Examine areas and conditions under which the system is to be installed. Do not proceed with the work until satisfactory conditions have been achieved.

C. Examine pathway elements intended for cables.

1. Verify proposed routes of pathways. Check raceways, cable trays, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with Electro Magnetic Interference (EMI) clearance requirements. Refer to Section 27150, Horizontal Cabling.

2. Identify plan to support cables and raceways in suspended ceilings. Verify weight of individual types and sizes of cables. Verify that load capacity of cable support structures is adequate for each pathway.

3.3 PATHWAY COORDINATION

A. Provide construction interference sketches showing detail of cable, tray & raceway supports, required deviations at interference points with utilities, equipment, etc.

B. Prepare wall penetrations and verify that penetrations of rated fire walls are restored using products labeled for type of wall penetrated.

C. Proceed with installation only after identified satisfactory solutions have been selected for unsatisfactory conditions.

3.4 HANDLING AND PROTECTION OF EQUIPMENT AND MATERIALS

A. Be responsible for safekeeping of your own and your subcontractor’s property, such as equipment and materials, on the job site. The Owner assumes no responsibility for protection of above named property against fire, theft, and environmental conditions.

3.5 PROTECTION OF EMU’S FACILITIES
A. Effectively protect the Owners facilities, equipment, and materials from dust, dirt, and damage during construction.

B. Remove protection at completion of work.

3.6 INSTALLATION

3.6.1 GENERAL

A. Receive, check, unload, handle, store, and adequately protect equipment and materials to be installed as part of the contract. Store in areas as directed by the Owners Representative. Include delivery, unloading, settling in place, fastening to walls, floors, ceilings, or other structures where required, interconnecting wiring of system components, equipment alignment and adjustment, and other related work whether or not expressly defined herein.

B. Install materials and equipment in accordance with applicable standards, codes, requirements, and recommendations of national, state, and local authorities having jurisdiction, and National Electrical Code (NEC) and with manufacturer’s printed instructions.

C. Consideration shall be given for operational efficiency and aesthetic factors in the installation of equipment and cables.

D. The data equipment (routers, switches, hubs, etc.) shall be furnished, installed and tested by Owner.

E. Existing EMU network infrastructure is based on a Cisco system.

F. Deviations from current standards are not acceptable without express written approval of the Owners Representative.

G. Due to field conditions or other situations, installation locations may have to be relocated a reasonable distance from the plan location. Unless relocations, modifications and reengineering are consistently or substantially unfavorable to either the contractor or the Owners Representative, there will be no additional charge or credit for this work.

H. The cabling contractor shall accomplish all cutting, removal and replacement of ceiling tile, drilling, coring and patching of walls, floors and ceilings required to complete this work.

I. Secure and support cables with suitable attachments (e.g. J-Hook cable hangers) at intervals not exceeding 60 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
J. Care must be taken to ensure cables are not kinked, bent beyond limit, overloaded, over-cinched, crushed, improperly untwisted, etc. Contractor may not hang any cable from existing lighting or ceiling supports.

K. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall be not be used for heating.

L. In unheated crawl spaces, Contractor is to install the cable at least four (4) feet from the exterior wall mounted securely to the slab or structure. Any cable support installation must attach securely to the deck.

M. No “stick-on” cable wraps, raceways or terminal devices are acceptable. All conduit, cable and raceway installation support must be mechanically fastened to walls, decks, slab, structure, etc. In general, adhesives and non-mechanical fastening methods of installation will not be acceptable.

N. Refer to Section 27050 “Basic Telecommunications Materials & Methods”.

3.6.2 FIELD QUALITY CONTROL

A. Every job superintendent or project manager during the course of the installation to provide coordination of work of this specification and of other trades, and provide technical information when requested by other trades. This person shall maintain current RCDD (Registered Communications Distribution Designer) registration and shall be responsible for quality control during installation, equipment set-up, and testing.

B. At least one on site personnel shall be BICSI Registered Telecommunications Installer. Installer performing connections, terminations, testing, etc. shall be registered at the Installer Level 2.

C. Installation personnel shall meet manufacturer’s training and education requirements for implementation of extended warranty program.

END OF SECTION 27000
SECTION 27050 – BASIC TELECOMMUNICATIONS MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Telecommunications Raceways.
   2. Supporting devices for telecommunication components.
   3. Identification.
   4. Concrete equipment bases.
   5. Cutting and patching for electrical construction.
   6. Touchup painting.
   7. Innerduct system.
   8. Aerial messenger systems.

B. Related sections include the following:
   1. Section 27060 “Underground Ducts and Utility Structures” for exterior duct, manholes, hand holes and underground utility construction.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. IMC: Intermediate metal conduit.
D. LFMC: Liquidtight flexible metal conduit.
E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS
A. Product Data: As specified herein.
B. Shop Drawings: Dimensioned plans, sections or elevation layouts of equipment, as requested.
C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE
A. Telecommunication Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

1.6 COORDINATION
A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the telecommunication installations that follow.
B. Sequence, coordinate, and integrate installing telecommunication materials and equipment for efficient flow of the Work:
   1. Coordinate access route for installation of new equipment and removal of existing.
   2. Coordinate access and set-up sites for cable reels, pulling equipment, etc.
C. Coordinate service connections to components furnished by utility companies.
   1. Coordinate installation and connection of exterior underground and overhead utilities and services.
   2. Comply with requirements of authorities having jurisdiction and of utility company providing telecommunication services.
D. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

PART 2 - PRODUCTS

2.1 RACEWAYS
A. EMT: ANSI C80.3, zinc-coated steel, with set-screw or compression fittings.
B. FMC: Zinc-coated steel.
C. IMC: ANSI C80.6, zinc-coated steel, with threaded fittings.
D. LFMC: Zinc-coated steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
E. RNC: NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.
F. Raceway Fittings: Specifically designed for the raceway type with which used.

G. METAL WIREWAYS

1. Manufacturers:
3. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
4. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
5. Wireway Covers: Flanged-and-gasketed type except as indicated otherwise.

2.2 L.V. POWER CONDUCTORS

A. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
B. Conductors, Larger Than No. 10 AWG: Stranded copper.
C. Insulation: Thermoplastic, rated at 75 deg C minimum.
D. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

2.3 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel unless specified otherwise.
C. Miscellaneous Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch diameter slotted holes at a maximum of 2 inches o.c., in webs.
D. Miscellaneous Slotted-Steel Channel Supports: Comply with requirements indicated for slotted channel framing.
   1. Channel Thickness: Selected to suit structural loading.
   2. Fittings and Accessories: Products of the same manufacturer as channel supports.
E. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch diameter holes at a maximum of 8 inch o.c., in at least one surface.
   1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers, bridle rings, cable manager assemblies, etc.

G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

I. Expansion Anchors: Carbon-steel wedge or sleeve type.

J. Toggle Bolts: All-steel springhead type.


2.4 BOXES, ENCLOSURES, AND CABINETS (NON-DATA)

A. Manufacturers:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. Emerson/General Signal; Appleton Electric Company.
   3. Erickson Electrical Equipment Co.
   6. RACO; Division of Hubbell, Inc.
   7. Robroy Industries, Inc.; Enclosure Division.
   8. Thomas & Betts Corporation.
   10. Quazite.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.


G. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.5 CONCRETE BASES

A. Concrete Forms and Reinforcement Materials: As indicated or specified in other sections.

B. Concrete: 3000-psi, 28-day compressive strength.

2.6 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.7 FIRESTOP SYSTEMS

A. Compatibility: Provide firestop systems that are compatible with the substrates forming openings, and with the items, if any, penetrating firestop systems, under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Accessories: Provide accessories required to install fill materials that comply with requirements of tested assemblies, are approved by qualified testing and inspecting agency that performed testing, and are specified by manufacturer of tested assemblies.

2.8 AERIAL MESSENGERS

A. Aerial messenger wire systems for supporting telecommunication cables shall be installed in accordance with Rule 251, NESC.

B. Anchors, guy wires, etc., shall be installed in accordance with the requirements of NESC.
2.9 INNERDUCT

A. Innerduct in Steam Tunnel:

1. Cables in steam tunnels shall be installed in non-corrugated polyethylene 2 cell, 1-1/4” orange innerduct.

2. The innerduct shall be:
   a. Foduct, model PE9009; or approved equal.

B. Innerduct Plugs:

1. Innerduct plugs shall be solid compression plugs. Plugs shall be:

C. Split Innerduct:

1. The split innerduct shall be:
   a. Arnco, model ARC-540-01-1-5/8 polyethylene corrugated split duct; or approved equal.

D. Transition Couplers:

1. New transition couplers shall be:
   a. Aeroquip, transition couplers for converting from 3-channel FoDuct to single innerduct.

E. Flexible Innerduct:

1. Where innerducts are required in raceways, use corrugated polyethylene innerduct.

2. The innerduct shall be:
   a. Arnco, model COR-500-125; or approved equal.
PART 3 - EXECUTION

3.1 TELECOMMUNICATION EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 RACEWAY APPLICATION

A. Use the following raceways for outdoor installations:

1. Exposed: IMC.
2. Concealed: IMC.
3. Underground, Grouped: RNC.
4. Connection to Vibrating Equipment: LFMC.
5. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.
6. Underground ductbank and manhole system.

B. Use the following raceways for indoor installations:

1. Exposed: EMT.
2. Concealed: EMT.
3. Connection to Vibrating Equipment: FMC; except in wet or damp locations, use LFMC.
4. Damp or Wet Locations: IMC.
5. Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.
6. Metal wireways and fittings.

C. Use the following raceways for steam tunnel installations:

1. Rigid PVC Schedule 40.
2. Plastic coated rigid galvanized steel conduit.

3.3 RACEWAY AND CABLE INSTALLATION

A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.
B. Install raceways and cables at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

C. Use temporary raceway caps to prevent foreign matter from entering.

D. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

E. Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.

F. Install pull wires in empty raceways. Use plastic or nylon line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

G. If a conduit run is over a hundred feet in length or contains more than two 90 degree bends, a pullbox is required, the location of which must be approved by the Engineer/Designer.

H. A third bend may be acceptable in a pull section without derating the conduit’s capacity if one of the following conditions is true:
   - The total run is not longer than 10m (33 ft)
   - The conduit size is increased to the next trade size
   - One of the bends is located within 12” of the cable feed end (this exception applies to placing operations where cable is pushed around the first bend)

3.4 SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer’s written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.5 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support telecommunication components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch- diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Install metal channel racks for mounting cabinets, pull and junction boxes and other devices unless components are mounted directly to structural elements of adequate strength.

K. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

L. Securely fasten telecommunication items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.
   a. Field Welding: Comply with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.6 IDENTIFICATION MATERIALS AND DEVICES

A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Refer to Sections 16075, 16124 and 16341.

3.7 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

B. Install fill materials for firestop systems by proven techniques.

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.8 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer’s anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as indicated.

3.9 DEMOLITION

A. Protect existing telecommunication equipment and installations indicated to remain. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality, and functionality as agreed upon by the Owner.

B. Accessible Work: Remove exposed telecommunication equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.10 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit telecommunication installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.11 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
5. Concrete bases.
6. Telecommunication demolition.
7. Cutting and patching for telecommunication construction.
8. Touchup painting.

3.12 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials shall match quality and type of existing finishes.

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
3.13 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, equipment and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.14 AERIAL INSTALLATION

A. Install and tension messenger wires, guy wires, etc., along the pole pathway.

B. Lash cables to the messenger wire and secure with clips at messenger wire supports on poles, structures, etc.

C. Ground messenger wire system.

D. Coordinate proposed work with utilities presently using the pole line.

3.15 INNERDUCT

A. Install innerducts in raceways as indicated and as required to complete the installation.

B. For a single cable, maximum fill shall be 53%. For 2 cables, the maximum fill shall be 31%. For 3 or more cables, the maximum fill shall be 40%.

C. Install raceways as straight as possible, avoiding unnecessary bends. Support raceways to prevent sagging or movement during pulling operations.

D. Install innerduct systems with fittings, etc., as approved by manufacturer and the Owners Representative and/or Engineer/Designer.

END OF SECTION 27050
PART 1 - GENERAL

1.1 SCOPE

D. Furnish, install and test an underground raceway system for the proposed Telecommunication Systems.

1.2 SECTION INCLUDES

A. This Section includes the following:

1. Ducts in concrete-encased duct banks.
2. Direct Buried Raceways
3. Grounding and Bonding System.
4. Excavation and Backfilling.
5. Handholes

1.3 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Handholes
2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
3. Concrete mixes
4. Bituminous mixes.

B. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:

1. For handholes, Shop Drawings shall show the following:

   a. Construction of individual segments.
   b. Joint details.
   c. Design withstand strength.
   d. Duct sizes and locations of duct entries.
   e. Reinforcement details.
   f. Cover design.
g. Grounding details.

1.5 QUALITY ASSURANCE
A. Telecommunication Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with ANSI C2.
C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver ducts/conduits to project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.7 PROJECT CONDITIONS
A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.
1. Notify the Owners Representative at least five (5) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the Owners Representative written permission.
B. Traffic: Minimize interference with adjoining roads, streets, walks and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks or other adjacent occupied or used facilities without permission from the Owners Representative and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
3. Provide traffic and detour signs, flagmen, barriers, warning lights, etc., as required and as requested by the Owners Representative.

1.8 COORDINATION
A. Coordinate layout and installation of raceways, handholes, etc. with existing arrangement of other utilities and site grading, as determined in the field.
B. Coordinate elevations of ducts and conduit entrances into handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit
field conditions and to ensure duct runs drain to handholes, and as approved by the Owners Representative and/or Engineer/Designer.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Nonmetallic Ducts and Accessories:
   a. Cantex, Inc.
   c. Lamson & Sessions; Carlon Electrical Products.

2. Handholes:
   a. Associated Plastics Inc. – Structural Plastic
   b. Advance Concrete Products Co. – Precast Concrete

2.2 CONDUIT

A. Conduit and fittings for cable mechanical protection, risers, etc.

2.3 DUCTS

A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.4 HANDHOLES

A. Handholes installed in vehicle traffic areas shall be precast concrete construction, and handholes installed in incidental traffic areas shall be polymer construction, unless indicated otherwise.

B. Polymer handholes shall be constructed with the following features:

1. Constructed from polymer and fiber reinforced plaster.

2. Cover secured with hexagon head bolts, non-skid surface and “Telecom-EMU” identification.

3. Live load 10,400 lbs. capacity for 10”x10” load area.
4. No floor.

5. Approximately 23"L x 16"w, 8" deep.

C. Precast concrete handholes shall be constructed with the following features:

1. Concrete: 4500 psi @ 28 days.

2. Reinforcing rebar for H-20 Highway Loading.

3. Approximately 4'0"x4'0"x3'0" deep solid floor with sump depression.

4. Cast iron cover 27" diameter.

2.4 2.5 **SOILS MATERIALS**

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: MDOT Class II granular material or better for backfill.

C. Backfill and Fill: Satisfactory soil materials.

D. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1 ½-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base: MDOT 21A or 21AA crushed stone.

F. Bedding: 1/4"-inch to 1 ½-inch angular graded stone or Class II sand compacted in six inch layers.

**PART 3 - EXECUTION**

3.1 **APPLICATION**

A. Underground Ducts for Communication Cables: Type EPC-40-PVC, direct buried, concrete encased, jack and bore or directional drilled, as applicable.

B. Handholes: Underground pre-fabricated handholes.

3.2 **EXCAVATION SUPPORT AND PROTECTION**

A. Design, furnish, install, monitor and maintain excavation support and protection system capable of supporting excavation sidewalls.

B. General: Provide materials that are either new or in serviceable condition.

C. Protect structures, utilities, sidewalks, pavements and other facilities from damage
caused by settlement, lateral movement, undermining, washout and other hazards that could develop during excavation support and protection system operations.

D. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks and other adjacent occupied and used facilities.

E. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage or other evidence of movement to ensure that excavation support and protection systems remain stable.

F. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

G. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures.

H. Dewater trench and other excavations, including material (stone, granular fill, concrete mud mat) to stabilize bottom of trench, etc.

3.3 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

B. Inspect, repair and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.4 LANDSCAPE PROTECTION

A. Erect and maintain temporary fencing around landscape and tree protection zones before starting site clearing. Remove fence when construction is complete.

B. Do not excavate within landscape-protected zones, unless otherwise indicated.

C. Trees and vegetation indicated to remain that are damaged by construction operations will be repaired at this Contract’s cost.

3.5 UTILITIES

A. Locate, identify, disconnect and seal or cap off utilities indicated to be removed.

3.6 EXCAVATION

A. Excavate to subgrade elevations regardless of the character of surface and subsurface
conditions encountered, including rock, soil materials and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

B. Excavate for structures, pavements and walks to indicated elevations and dimensions. Extend excavations for placing and removing concrete formwork, for installing services and other construction, and for inspections. Trim bottoms to required lines and grades to leave solid base to receive other work.

C. Excavate utility trenches to indicated gradients, lines, depths and invert elevations of uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit.

1. Excavate trenches 3 inches deeper than bottom of duct elevation, to allow for bedding course (granular backfill or stone) as indicated on the drawings.

D. Proof roll subgrades, before filling or placing aggregate courses.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities.

F. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Project Manager.

G. Stockpile borrow materials and satisfactory soil materials, without intermixing, in shaped, graded, drained and covered stockpiles. Stockpile soil materials away from edge of excavations and outside drip line of remaining trees, etc.

3.7 BACKFILLS AND FILLS

A. Utility Trench Backfill: Place, compact and shape bedding course to provide continuous support for conduits over rock and other unyielding bearing surfaces and to fill unauthorized excavations.

B. Fill: Place and compact fill materials in layers to required elevations.

C. Compaction: Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers and fill material in duct bank trench.

D. Compact soil to not less than the following percentages of maximum dry density according to ASTM D 698.

1. Under structures, building slabs, steps and pavements, scarify and re-compact top 12 inches of existing subgrade and each layer or backfill or fill material at 95 percent.
2. Under landscape areas, compact each layer of backfill or fill material at 85 percent.

F. Grading: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines and elevations indicated.

G. Subbase and Base Courses: Under pavements and walks, place subbase course on prepared subgrade. Place base course material over subbase. Compact to required grades, lines, cross sections and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

H. Field Quality Control:
   1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
   2. Allow testing agency to test and inspect subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
   3. When testing agency reports that subgrades, fills or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

3.2 3.8 RESTORATION

A. Restore surface finishes at areas disturbed by excavation and reestablish original grades, unless otherwise indicated.

B. Restore disturbed bituminous and concrete pavement.

3.9 CONDUIT AND DUCT INSTALLATION

A. Slope: Pitch ducts down toward manholes and away from equipment. Slope ducts from a high point in runs between two handholes to drain in both directions.

C. Curves and Bends: Use 3 ft. radius elbows for stub-ups at equipment entrances. Use long sweep bends with a minimum radius of 5 feet, both horizontally and vertically, at other locations. Should cable manufacturer bend radius requirements be greater, adjust radius elbows and long sweep bends accordingly.

C. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturers written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Duct Entrances to Handholes: Space end bells approximately 10 inches one center.

E. Concrete-Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as
recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. **Separator Installation:** Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6 inches between tiers. Tie entire assembly together using fabric straps, tie wires or reinforcing steel.

2. **Concreting:** Pour concrete carefully during placement to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use planks or sluice conveyors to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope. **Reinforcement:** Reinforce duct banks where they cross disturbed earth and where indicated.

3. **Forms:** Use walls of trench to form sidewalls of duct bank where soil is self-supporting and concrete envelope can be placed without soil inclusions; otherwise, use forms.

**F. Warning Tape:** Bury detectable warning tape approximately 12 inches above all duct/conduit pathways. Align tape parallel to and within 3 inches of the centerline of ducts. Terminate tape ends in manholes, handholes, etc.

**G. Sealing:** Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

**H. Pulling Cord:** Install 200-lbf-test nylon cord in ducts, including spares.

**I. Re-rods:** Use steel reinforcing rods, as applicable.

**3.10 HANDHOLE INSTALLATION**

**J. Elevation:** Install handholes with cover/rim. Set frames 1 inch above finished grade.

**K. Access:** Install cast-iron frame and cover.

1. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

2. Set frames 1 inch above finished grade.

**L. Grounding:** Install ground rod through floor of handhole with top protruding 4 inches above floor. Ground exposed metal components and hardware with bare-copper ground conductors and train conductors.
D. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

E. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, and compacted to same density as adjacent undisturbed earth.

F. When installing polymer handholes, brace interior and secure cover before backfilling and compacting the unit in place.

G. Terminate ducts 4” above floor.

3.11 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures. Testing must be witnessed by the Owners Representative and/or Engineer/Designer.

B. Grounding: Test handhole grounding to ensure electrical continuity of grounding and bonding connections.

C. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.

D. Review installation deficiencies with the Owners Representative and propose corrective solutions, and submit selected solution for the Owners Representative and/or Engineer/Designer approval. After receipt of Project Manager’s written approval correct installations and retest to demonstrate compliance.

3.12 DUCT CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of handholes and remove foreign material, etc.

END OF SECTION 27060
SECTION 27110 – TELECOMMUNICATIONS EQUIPMENT ROOM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. This section specifies the structured system cabling equipment and components in a Communications Equipment Room.
   2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

B. Related Sections:
   1. Division 1 – General Requirements
   2. Section 27000 – Communications General
   3. Section 27170 – Telecommunications Administration

1.2 SYSTEM DESCRIPTION

The equipment room (ER) includes those products that connect the networking equipment to the horizontal and backbone cabling subsystems. These products include termination hardware (connectors and patch cords), racks, cable management products and cabling routing products.

1.3 SUBMITTALS

A. Shop Drawings
   1. Termination Hardware
   2. Cable Management components.
   3. Equipment racks, enclosures, patch panels, and all related components.

B. Refer to Section 27000 for additional submittal information as related to this topic.

1.4 QUALITY ASSURANCE

A. Refer to Section 27000 for quality assurance requirements.

PART 2 – PRODUCTS

2.1 MANUFACTURERS
Product selection subject to compliance with the Owner standard requirements, provide products by one of the manufacturers specified.

2.2 FABRICATION

Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.

2.3 SUITABILITY

Provide products that are suitable for intended use, including, but not limited to environmental, regulatory, and electrical.

2.4 UTP TERMINATION HARDWARE

A. Patch Panels and Patch Cords (Data)

1. Four-pair Category 6 UTP cabling shall be terminated onto 19 inch rack mountable, 24-port 8-pin modular to insulation displacement connector (IDC) meeting or exceeding Category 6 performance standards, and pinned to T568B standard. Integral cable tie mounts shall be included in the panel for cable management on the back of the panel. Port and panels shall be easy to identify with write-on areas and optional label holder for color-coded labels.

Number of Jacks per Field: One for each four-pair Category 6 UTP cable plus spares and blank positions adequate to satisfy specified expansion criteria.

2. Patch Cords shall be used between modular patch panels configured as cross-connect or between the patch panel and networking hardware when the patch is used as an interconnect. The patch cords shall be factory terminated with modular plugs featuring a one-piece, tangle-free latch design and strain-relief boots to support easy moves, add and changes. They shall be constructed with Category 6 24-AWG stranded UTP cable. Each cord shall be 100% performance tested at the factory in a channel test to the ANSI/TIA/EIA Category 6 standard. Required cable lengths and colors shall be approved by the Engineer/Designer prior to ordering.

3. Approved Manufacturers: Panduit, Siemon, Hubbell

B. Punchdown 110 Base and System (Voice)

1. Category 6 UTP cable shall be terminated upon a standard density 110 style Category 6 connecting block, providing for the termination of 6 four pair cables per horizontal row.
2. Category 6 UTP patch cords shall be used between 110 style connecting bases when configured as a cross-connect or between the connecting block and networking hardware when the connecting block is used as an interconnect. Patch cords shall be 24 AWG stranded Category 6 cable. The cable shall be terminated onto 110 style plugs tested to exceed Category 6 performance when used in a channel with the specified Category 6 modular jacks. The patch cords shall be in gray in color, shall be field terminable and shall employ a clear cap for wiring identification.

3. Approved Manufacturers: Panduit, Siemon, Hubbell

2.5 FIBER TERMINATION HARDWARE

A. Fiber Connectors and Patch Cords

1. SC ceramic tipped fiber optic connectors shall be field terminable duplex fiber optic connectors for multimode and singlemode glass fiber that fully complies with both the fiber optic connector performance requirements specified in ANSI/TIA/EIA-568-B.3. The multimode SC connector shall be compatible with 50/125μm, 3.0 mm jacketed or 900μm tight-buffered multimode fiber or 9/125μm singlemode glass fiber. The connector shall have an insertion loss typically less than 0.3 dB per fiber. They shall be capable of field termination with commonly available tools. The cover and boots of the multimode SC connector shall be the industry standard electric ivory color signifying multimode fiber and blue signifying singlemode fiber.

2. SC optical fiber patch cords shall be constructed from high performance 50/125μm multimode cable and SC duplex connectors with ceramic ferrules. Integral boots shall be provided to provide strain relief and help maintain consistent polarity. Required cable lengths and colors shall be approved by the Engineer/Designer prior to ordering.

3. Approved Manufacturers: Corning (CCH-CP12-91), Panduit, Siemon

B. Wall Mounted Optical Fiber Patch Panels

1. Wall-mounted optical fiber termination panel with 12-fiber capacity, hinged door, cable strain relief, slack storage, and two 6-port SC or approved alternative connector panels with adapters and provision for two splice trays.

2. The use of wall-mounted patch panels is subject to the express written consent of the Engineer/Designer.
3. Approved Manufacturers: Corning, Panduit, Siemon.

C. Rack Mounted Optical Fiber Connector Housing Panel

1. 19 inch rack mounted, 4U, 72-port rack-mounted optical fiber connector housing panel with blank panels and cable strain relief hardware and grounding kit.

2. Approved Manufacturer: Corning LANscape (Part No. CCH-04U).

D. Optical Fiber Connector Housing Modules

1. Connector Panel with six 568SC (SC Duplex) adapters, single-mode and/or 50µm multimode, ceramic insert, composite housing.


E. Splice Trays

1. Sized for singlemode and multimode fibers, aluminum with clear plastic cover, splice capacity as indicated on contract documents, compatible with splice enclosure and splicing method.

2. Approved Manufacturers: Corning, Panduit, Siemon

F. Indoor/Outdoor Loose Tube Fan-Out Kits.

1. Field termination of loose tube cables at indoor or outdoor cross connects.

2. Manufacturer assembled 900µm fan-out assembly, color-coded to match the fiber color scheme, 47 inches in length. 6- or 12-fiber unit as required.

3. Approved Manufacturers: AFL, Corning, Mohawk/CDT

2.6 CABLE MANAGEMENT

The cable management system shall be used to provide a neat and efficient means for routing and protecting fiber and copper cables and patch cords on telecommunication racks and enclosures. The system shall be a complete cable management system comprised of vertical and horizontal cable managers to manage cables on both the front and rear of the rack. The system shall protect network investment by maintaining system performance, controlling cable bend radius and providing cable strain relief.

A. Rack System
1. Cable Management shall be provided using a rack system that supports heavy equipment and high capacity cable for cross connect or interconnect applications in a telecommunications room. The rack system shall meet all EIA requirements as defined in EIA-310-D.

B. Equipment Cabinets

1. Equipment cabinets shall accommodate both 19” and 23” components.
2. 78 inch (44 rack spaces) of panel space
3. 31.75” depth
4. Welded steel frame construction
5. Locking front and rear doors
6. Rack-mount equipment shelf
7. Adjustable front and back equipment mountain rails drilled and tapped to EIA standards
8. 9 position electrical outlet strip (refer to 2.6.E)
9. Removable side panels
10. Medium duty casters
12. Smoked acrylic front door
14. Approved Manufacturers: Hubbell (Part No. HPW78C19X30E and HPWRFANLN) or approved equal.

C. Floor-Mounted Equipment Rack

1. Steel, open frame, modular, free-standing with vertical and horizontal cable management channels. Top and bottom cable troughs, and grounding lug. 19 or 23 inch equipment rack, 7 foot 6 inch overall height with flange base, mounting rails drilled front and back and tapped to EIA standards, and a front-rack mountable 10 outlet multiple electrical outlet strip.
Overhead ladder racks to parallel walls where appropriate for stability and cable management.

2. Approved Manufacturers: Panduit, Hammond, Homaco, Hubbell, Middle Atlantic Products, X-Mark/CDT

D. Wall-Mounted Equipment Rack

1. Aluminum, open frame, hinged wall bracket with provisions for power strip mounting.

2. The use of wall-mounted equipment racks is subject to the express written consent of the Engineer/Designer.

3. Approved Manufacturers: Panduit, Hammond, Homaco, Hubbell, Middle Atlantic Products, X-Mark/CDT

E. Power Strips

1. For mounting in the rack, with 15A, 120VAC, Nine (9) NEMA 5-15R receptacle configuration.

2. Always on outlets, catastrophic event protection, cord management and lightning & surge protection

3. Protection working indicator, site wiring fault indicator and status indicator LED’s

4. Cord Management Rails, Plug Pull Protectors and Rack Mounting Brackets

5. Cord connected with 15-foot (4.5-m) line cord.

6. Rocker-type on-off switch

7. Approved Manufacturers: APC (Part No. NET9RM) or approved equal.

F. Vertical Cable Management

1. Vertical cable managers shall include components that aid in routing, managing and organizing cable to and from patch panels and/or equipment. Managers shall protect network equipment by controlling cable bend radius and providing cable strain relief. Managers shall be a universal design mounting to EIA 19” or 23” racks and must be installed on each side of the rack, and between racks when more than one rack is installed.
2. All cables within wire management racks will be cable wrapped with velcro cable ties at no greater than one foot intervals.

3. Approved Manufacturer: Panduit Part #WMPV45

G. Horizontal Cable Management

1. Horizontal cable managers shall include components that aid in routing, managing, and organizing cable to and from patch panels and/or equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a universal design mounting to EIA 19” or 23” racks and must be installed above and below every installed patch panel.

2. All cables within wire management racks will be cable wrapped with velcro cable ties at no greater than one foot intervals.

3. Approved Manufacturer: Panduit Part #WMPH2

H. Cabinet Cable Management

1. Cabinet cable management system shall include components that aid in routing, managing and organizing cable to and from patch panels and/or equipment within a cabinet. Managers shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a flexible design with adjustable mounting. Panels shall be constructed PVC duct with steel mounting brackets attached. Duct fingers shall have score lines for easy removal.

2. Approved Manufacturer: Panduit

I. Raised Access Floor

Access floors are commonly used to route equipment cables to cross-connects in large Equipment Rooms

1. The use of cable trays or other suitable means for cable management and protection under access flooring must be designed and approved by the Engineer/Designer.

2. NEC article 645 provides requirements for placing cable under access floors.
3. Load bearing capacity of the access floor shall be 100 lb/ft² for uniform load capacity and 2000 lb/ft² for concentrated load capacity.

4. Floor panels are to be covered with high pressure laminate, vinyl or other durable tile.

5. All metal parts of an access floor should be bonded to ground.

PART 3 - EXECUTION

3.1 EQUIPMENT ROOM

A. SPACE ALLOCATION

1. The layout of the major telecommunications equipment in an ER must facilitate the routing of electrical power and telecommunications cabling. A space of at least 10 ft x 15 ft should be allocated, unless otherwise specified by the Engineer/Designer.

B. CABLELING:

1. All cabling shall be bundled and properly secured and terminated in the telecommunications room. Cables must be properly supported and separated to avoid crushing or cinching.

C. BACKBOARDS:

1. Install 4’ x 8’ x ¾” UL Listed fire retardant, oil resistant, painted plywood backboards from floor up toward ceiling. Refer to drawings for quantity counts. Butt adjacent sheets tightly, and form smooth gap-free corners.

2. Provide D rings on plywood backboards for wire management. Space rings no greater than 12” apart.

D. CONDUITS:

1. In the telecommunications rooms, position conduit ends adjacent to a corner on backboard (in case of a single piece of plywood) or in the corner of the room (where multiple sheets of plywood are installed around perimeter walls of room). Use cable trays to route cables if conduits cannot be located in these positions. Secure conduits to backboard when entering room from overhead. Extend conduits 1 to 3 inches (25 to 76 mm) in finished floor.
E. CABLE TRAYS:

1. In the telecommunications rooms, provide at least one (36"W x 6"H x determined L) cable tray to support the incoming cable feeds and to provide cable entrance to the racks. Cable trays shall have appropriate bend radii for copper and fiber cables.

F. RACKS:

1. Racks are to be properly installed, attached to floor, and secured to handle the equipment load. Overhead ladder racks to parallel walls for stability and cable management.

2. There must be at least one foot of side clearance to the nearest wall and four feet of clearance in the front and back of the telecommunication racks for accessibility purposes.

G. POWER:

1. Each telecommunications room shall be equipped with a minimum of one dedicated 20 amp 120v circuit for every freestanding rack that is installed unless otherwise specified by the Engineer/Designer, with a minimum of 2 installed circuits. The power will be conditioned power on or near each data rack. All plans for telecommunications room power must be approved by the Owners Representative and/or Engineer/Designer prior to implementation to ensure enough power exists to support the planned equipment and future growth. If the Engineer/Designer will not have keys and access to the electrical breaker panel for the data rack circuits, then a dedicated breaker must be installed inside the communications room.

H. ENVIRONMENT:

1. The environment of the rooms that are identified to house the network equipment (i.e. Equipment Room – ER) must be controllable from the room itself. The controls in a communication room must affect only its environment, and the room should not be affected by controls located outside of it. Air-conditioning must be year-round. HVAC sensors and controls shall ideally be placed 5 ft above finished floor (AFF).
2. The environmental control systems for the ER should meet a temperature requirement of 18°C to 24°C (64°F to 75°F), a relative humidity requirement of 35% to 55% and a heat dissipation requirement of 750 to 5,000 British thermal unit (BTU) per hour per cabinet.

3. Filtration systems may be required to minimize particle levels in the air, as specified in the contract documents.

4. Each communications room will be a dedicated room with the power and environment requirements met according to the above specifications. Communications rooms will not be shared by other functions. Provide sufficient space, if specified, for Owner provided telephone or cable TV equipment.

END OF SECTION 27110
SECTION 27130 – BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. This Section specifies the inter and intra backbone cabling system for buildings and structures within EMU’s campus.

2. Furnish and install a complete backbone cabling system with all necessary components for a complete system as described in the specification and shown on the drawings.

B. Related Sections:

1. Division 1 – General Requirements
2. Section 27000 – Communications General
3. Section 27050 – Basic Telecommunications Materials & Methods
4. Section 27060 – Underground Raceways & Structures
5. Section 27170 – Telecommunications Administration

1.2 SYSTEM DESCRIPTION

A. The Backbone Cable subsystem in a building is the part of the premise distribution system that provides connection between equipment rooms (ERs), telecommunication rooms (TRs), telecommunication enclosures (TEs) and telecommunications service entrance facilities (EFs). A backbone subsystem provides either intra-building connections between floors in multi-story buildings or inter-building connections in EMU’s campus environment.

B. All cables shall be run using a star topology (home run) from the Main Cross-Connect (MC) to each Horizontal Cross-Connect (HC) within the telecommunications room. Intermediate Cross-Connect’s (IC) may be implemented between the MC and HC if so required.

1.3 SUBMITTALS

A. Shop Drawings

1. Copper and/or Fiber optic cabling.
2. Equipment racks, enclosures, patch panels, and all related components.
3. Connectors

B. Refer to Section 27000 for additional submittal information as related to this topic.
1.4 QUALITY ASSURANCE

A. In general, all backbone cabling and equipment shall comply with ANSI/TIA/EIA-568-B.1 & applicable addendums, ANSI/TIA/EIA-568-B.2 & applicable addendums, ANSI/TIA/EIA-568-B.3 & applicable addendums, ANSI/TIA/EIA-569-B, ANSI/TIA/EIA-758 and NFPA 70 (National Electrical Code).

B. Refer to Section 27000 for additional quality assurance information as related to this topic.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

Product Selection, subject to compliance with the Owners standard requirements, provide products by one of the manufacturers specified.

2.2 FABRICATION

Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.

2.3 SUITABILITY

Provide products that are suitable for intended use, including, but not limited to environmental, regulatory, and electrical.

2.4 VOICE BACKBONE CABLES

A. Multi-pair copper cable shall be used and shall be listed per NEC Article 800-51 for a voice backbone.

B. Category 6 UTP Cable

1. Solid copper, 24 AWG, 100 Ω balanced twisted-pair backbone cable, in sizes as indicated on the drawings, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA-568-B.2

2. All cable shall conform to the requirements for communications circuits defined by the National Electrical Code (Article 800). All cable shall be listed to NEC Article 800-51(b).

3. Approved Manufacturers: AFL, Corning, Commscope, Mohawk-CDT
C. Underground Category 6 UTP Cable

1. Solid copper, 24 AWG, 100 Ω balanced twisted-pair, gel-filled duct cable, in sizes as indicated on the drawings, which meet or exceed the mechanical and transmission performance specifications listed in ANSI/TIA/EIA-758(A).

2. Cables installed outside between buildings shall have overvoltage protectors on both ends of the cable.

3. Approved Manufacturers: AFL, Corning, Commscope, Mohawk-CDT

2.5 DATA BACKBONE CABLES

A. The type of backbone data cable used shall be based on a given application. Key factors in determining which optical fiber to use are active equipment, distance and bandwidth (data rate).

B. Multimode Fiber - 10BASE-FL / 100BASE-FX (Ethernet / Fast Ethernet)

1. Backbone data cable shall be multimode 50/125μm diameter tight-buffered optical fiber, with fiber counts as indicated on drawings, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA-568-B.3.

2. The length of each individual run of backbone fiber cable for this application shall not exceed 2000 meters (6,562 ft).

3. Listed type OFNP, OFNR, OFCR, and/or OFCP (as required by NEC 2002)

4. Approved Manufacturers: AFL, Corning, Commscope, Mohawk-CDT

C. Multimode Fiber - 1000BASE-LX (Gigabit Ethernet)

1. Backbone data cable shall be multimode 50/125μm diameter tight-buffered optical fiber, with fiber counts as indicated on drawings, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA-568-B.3.

2. The length of each individual run of backbone fiber cable for this application shall not exceed 550 meters (1804 ft).

3. Listed type OFNP, OFNR, OFCR, and/or OFCP (as required by NEC 2002)
D. Singlemode Fiber - 1000BASE-LX (Gigabit Ethernet)

1. Backbone data cable shall be singlemode 9/125μm diameter tight-buffered optical fiber, with fiber counts as indicated on drawings, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA-568-B.3.

2. The length of each individual run of backbone fiber cable for this application shall not exceed 5000 meters (16,404 ft).

3. Listed type OFNP, OFNR, OFCR, and/or OFCP (as required by NEC 2002)

4. Approved Manufacturers: AFL, Corning, Commscope, Mohawk-CDT

E. Direct-Buried & Aerial Optical Fiber (Loose-Tube)

1. Multimode 50/125μm diameter, armored, gel-filled optical fiber, with number of usable fibers as shown on drawings, with the mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA-568-B.3.

2. Singlemode 9/125μm diameter, armored, gel-filled optical fiber, with number of usable fibers as shown on drawings, with the mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA-568-B.3.

3. Listed type OFNR (as required by NEC 2002).

4. Approved Manufacturers: AFL, Corning, Commscope, Mohawk-CDT

2.6 OPTICAL FIBER CONNECTORS

A. Connectors

1. SC ceramic tipped fiber optic connectors shall be field terminable duplex fiber optic connectors for multimode and singlemode glass fiber that fully complies with both the fiber optic connector performance requirements specified in ANSI/TIA/EIA-568-B.3. The multimode SC connector shall be compatible with 50/125μm, 3.0 mm jacketed or 900μm tight-buffered multimode fiber or 9/125μm singlemode glass fiber. The connector shall have an insertion loss typically less than
2. Approved Manufacturers: Corning, Panduit, Siemon

B. Pigtails

1. Manufacturer assembled 50/125 µm (and/or singlemode) optical fiber pigtail 1m long with 3.0 mm single 568 SC optical fiber connectors on one end.

2. Pigtails shall have a length of at least 1 meters or be sufficient to reach the entire length of the fiber optic rack or cabinet, whichever is greater.

3. All pigtails shall be labeled with a durable label in accordance with the labeling scheme described in Section 27170.

4. The maximum loss of any pigtail’s connector is 0.3 dB.

5. The optical return loss for each pigtail’s connector shall be greater than 30 dB.

6. Pigtails shall be fusion spliced to the fiber optic cable.

7. The use of pigtails is subject to the express written consent of the Engineer/Designer.

8. Approved Manufacturers: Corning, Panduit, Siemon

C. Optical Fiber Jumpers

1. Dual 50/125µm (and/or singlemode) optical fiber jumper cable, 1m long with 4.0mm Duplex 568 SC optical fiber connectors on each end.

2. Dual 50/125µm (and/or singlemode) optical fiber jumper cable, 1m long with approved alternative duplex optical fiber connectors on each end.

3. Approved Manufacturers: Corning, Panduit, Siemon

D. Indoor/Outdoor Loose Tube Fan-Out Kits

1. Field termination of loose tube cables at indoor or outdoor cross-connects.
2. Manufacturer assembled 900µm fan-out assembly, color-coded to match the fiber color scheme, 25 or 47 inches in length. 6- or 12-fiber unit as required.

3. Approved Manufacturers: Corning, Panduit, Siemon

## 2.7 EQUIPMENT

**A. Wall Mounted Optical Fiber Patch Panels**

1. Wall-mounted optical fiber termination panel with 12-fiber capacity, hinged door, cable strain relief, slack storage, and two 6-port SC or approved alternative connector panels with adapters and provision for two splice trays.

2. The use of wall-mounted patch panels is subject to the express written consent of the Engineer/Designer.

3. Approved Manufacturer: Corning, Panduit, Siemon

**B. Rack Mounted Optical Fiber Connector Housing Panel**

1. 19 inch rack mounted, 4U, 72-port rack-mounted optical fiber connector housing panel with blank panels, cable strain relief hardware and grounding kit.

2. Approved Manufacturer: Corning LANscape (Part No. CCH-04U)

**C. Optical Fiber Connector Housing Modules**

1. Connector Panel with six 568SC (SC Duplex) adapters, single-mode and/or 50µm multimode, ceramic insert, composite housing.


**D. Splice Trays**

1. Splices are to be minimized and must be approved by the Owners Representative and/or Engineer/Designer.

2. Where required, all splices shall be fusion type and contained in splice trays. Sized for singlemode and multimode fibers, aluminum with clear plastic cover, splice capacity as indicated
on contract documents, compatible with splice enclosure and splicing method.

3. Approved Manufacturers: Corning, Panduit, Siemon

E. Splice Enclosures

1. Encapsulated, re-enterable splice housing, sized as required with bonding straps, accessories, end caps and encapsulant as required.

2. Approved Manufacturers: AFL, Corning

F. Hose Racks

1. Hose racks shall be installed to hang large coils of fiber optic cable on.

2. Approved Manufacturer: Spencer Turbine Co., model RKV-90000 for loops of cable 200’ or less, model RKV-90003 for loops of cable over 200’, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Each new building will minimally require 24 strands of singlemode and 24 strands of multimode fiber run, unless otherwise noted on the drawings, from the IC to the nearest MC. Any necessary terminations between the MC and the new IC shall be performed.

B. Cable manufacturer’s recommendations shall be followed during installation of cable. Pull force shall be monitored and shall not exceed manufacturer’s ratings.

C. When a winch or pulling machine is used during installation, a dynamometer shall be used to monitor the tension on the cable. Submit record printouts to the Owners Representative.

D. Precautions shall be taken to avoid imparting twist or torque to the cable during installation. Implement the use of pulling swivels and figure-eighting the cable as required.

E. Cable endcaps shall be used at all times to prevent moisture from entering the cable.
F. Following cable pull-in, the cable end to which the cable puller is fastened shall be removed and discarded. A minimum of three meters of cable shall be removed.

G. Cable pulling compounds shall be compatible with the fiber optic cable in accordance with cable manufacturers recommendation.

3.2 INTERIOR BACKBONE CABLELING SYSTEM

A. Cables located inside buildings shall be installed in conduit to the designated communication rooms.

B. Support riser cables every three (3) floors and at top of run with cable grips. Limit number of four-pair data riser cables per grip to fifty (50).

C. The minimum bend radius of the fiber optic cable shall be 10 times the cable outside diameter under no load and 15 times the cable outside diameter when being pulled or as rated by the manufacturer, whichever is greater. Minimum bend radius shall be observed at all times.

D. A new cable tray shall be installed in each communication room, if one does not exist, to train the cables over to the communication racks. Ends of trays shall be supported from the wall. Trays longer than 10’ shall also be supported at midspan from the deck above. The fiber optic cable shall be installed in the tray separate from the twisted pair cable to avoid having the twisted pair cable bear any weight on the fiber optic cable.

E. A 30’ service loop of cable shall be provided in the cable tray above each fiber optic cabinet.

F. The cable shall be properly secured at the fiber housing panel using manufacturers recommended means for attachment.

G. Arrangement of the components in the fiber rack and cabinets shall be approved by Engineer/Designer prior to installation.

H. Install one new connector housing panel in each communication room in the communication rack.

I. In each connector housing panel, each cable shall be labeled with the room name from which the cable came.

J. Tight-buffered cabling shall be field connectorized with SC type connectors.
K. In the final termination of loose-tube cabling with SC type connectors, each new fiber shall be fed through the tubes of a breakout kit and protected in the fiber optic connector housing panel.

3.3 EXTERIOR BACKBONE CABLELING SYSTEM

A. Cables located inside buildings shall be installed in conduit or cable tray to the designated communication rooms.

B. The minimum bend radius of the fiber optic cable shall be 10 times the cable outside diameter under no load and 20 times the cable outside diameter when being pulled or as rated by the manufacturer, whichever is greater. Minimum bend radius shall be observed at all times.

C. A new cable tray shall be installed in each communication room, if one does not exist, to train the cables over to the communication racks. Ends of trays shall be supported from the wall. Trays longer than 10’ shall also be supported at midspan from the deck above. The fiber optic cable shall be installed in the tray separate from the twisted pair cable to avoid having the twisted pair cable bear any weight on the fiber optic cable.

D. A 30’ service loop of cable shall be provided in the cable tray above each fiber optic cabinet.

E. Tight-buffered cabling shall be field connectorized with SC type connectors.

F. In the final termination of loose-tube cabling with SC type connectors, each new fiber shall be fed through the tubes of a breakout kit and protected in the fiber optic connector housing panel.

3.4 TESTING


B. For backbone lengths and channels that do not exceed the length limits for horizontal cables, the test limits for horizontal cabling can be used.
C. Test each pair and shield of each cable for open circuits, short circuits, grounds, crossed pairs, reversed pairs, split pairs, and improper terminations. Correct grounded and reversed pairs. Examine open and shorted pairs to determine if problem is caused by improper termination. If termination is proper, tag bad pairs at both ends and note on termination sheets.

1. Perform testing of copper cables with test instruments meeting or exceeding applicable requirements in ANSI/TIA/EIA-568-B.2.

2. Channel and permanent link tests for wire map, cable length, insertion loss, near-end crosstalk loss (NEXT), power sum near-end crosstalk loss (PSNEXT), equal-level far-end crosstalk loss (ELFEXT), power sum equal-level far-end crosstalk (PSELFEXT), return loss, propagation delay, and delay skew. Tests shall be performed with a tester that complies with performance requirements in ANSI/TIA/EIA-568-B.2, Level III. Include tests for longitudinal or transverse conversion loss.

3. If copper backbone cable contains more than one (1) percent bad pairs, remove and replace entire cable.

4. If copper cables contain more than the following quantity of bad pairs, or if outer sheath damage is cause of bad pairs, remove and replace the entire cable:

<table>
<thead>
<tr>
<th>CABLE SIZE</th>
<th>MAXIMUM BAD PAIRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100</td>
<td>1</td>
</tr>
<tr>
<td>101 to 300</td>
<td>1-3</td>
</tr>
<tr>
<td>301 to 600</td>
<td>3-6</td>
</tr>
<tr>
<td>&gt; 601</td>
<td>6</td>
</tr>
</tbody>
</table>

5. If backbone cable contains bad conductors or shield, remove and replace cable.


1. Cables shall be tested at both 850 and 1300 nm for multimode optical fiber cables. Cables shall be tested at both 1310 and 1550 nm for singlemode optical fibers.

3. All system connectors, adapters, and jumpers must be properly cleaned before measurements are taken.

4. Bi-directional testing of optical fibers is required.

E. Perform optical time domain reflectometer (OTDR) testing per Tier 2 of TSB-140 on each fiber optic conductor. Measured results shall be plus/minus 1 dB of submitted loss budget calculations.

1. Submit printout for each cable tested.

2. Submit 3.5 inch disks with test results and program to view results.

F. Where any portion of system does not meet the specifications, correct deviation and repeat applicable testing at no additional cost to the Owner.

END OF SECTION 27130
SECTION 27150 – HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. This Section specifies the horizontal cabling system for buildings and structures.
2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.
3. The Contractor shall furnish and install a complete horizontal cabling system with all necessary components for a complete system as described in the specification and shown on the drawings.

B. Related Sections:

1. Division 1 – General Requirements
2. Section 27000 – Communications General
3. Section 27050 – Basic Telecommunications Materials & Methods
4. Section 27170 – Telecommunications Administration

1.2 SYSTEM DESCRIPTION

The horizontal cabling system is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector to the horizontal cross-connect in the Telecommunications Room (TR).

- Horizontal cabling should terminate in a TR located on the same floor as the work area being served or as otherwise specified by the Engineer/Designer.
- Horizontal cabling is installed in a star topology (home run).
- Bridged taps and splices are not permitted as part of the copper horizontal cabling.

1.3 SUBMITTALS

A. Shop Drawings

1. Copper and/or Fiber cabling.
2. Equipment racks, enclosures, patch panels, and all related components.
3. Outlets

B. Refer to Section 27000 for additional submittal information as related to this topic.
1.4 QUALITY ASSURANCE


B. Refer to Section 27000 for additional quality assurance information as related to this topic.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

Product selection subject to compliance with the Owners standard requirements, provide products by one of the manufacturers specified.

2.2 FABRICATION

Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.

2.3 SUITABILITY

Provide products that are suitable for intended use, including, but not limited to environmental, regulatory, and electrical.

2.4 CATEGORY 6 COPPER UTP CABLE

A. 4-pair 100 ohm 24 AWG, Category 6 UTP cable. Cable must meet or exceed the mechanical and transmission performance specifications in ANSI/TIA/EIA-568-B.2, up to 350Mhz or better.

B. Data cable jacket color: Blue

C. Voice cable jacket color: Gray

D. All cable shall conform to the requirements for communication circuits defined by the National Electrical Code (Article 800). Cable listed to NEC Article 800-51(a) CMP will be used for all installations where required by code.

E. The cable manufacturer shall be ISO 9001 registered.

F. Every master reel shall be tested for Attenuation, NEXT, Power Sum Crosstalk, Impedance and RL. This testing shall be performed using a sweep test method and include frequencies from .772 Mhz to 350Mhz.
G. A test report shall be attached to each reel of cable indicating the Master reel number, the date of the test, and test results for SRL, Attenuation, Crosstalk (NEXT). Power Sum may be listed as Pass/Fail. Characteristic impedance shall be shown for each pair.

H. Approved Manufacturers: Commscope, Optical Cable Corporation, Mohawk/CDT

2.5 FIBER CABLE

When using optical fiber cables, any length of horizontal cables, work area cables, patch cords, and equipment cables is acceptable so long as the total of the combined lengths does not exceed 100 m (328 ft). When installing per TSB72, Centralized Optical Fiber Cabling Guidelines, the maximum cable length may not exceed 300 m (984 ft).

A. Transmission is typically 850 or 1300 nm for 50/125μm multimode optical fiber.

B. Meet or exceed ANSI/TIA/EIA-568-B.3 Horizontal fiber cable distribution systems.

C. The optical fiber cable shall consist of a minimum of two 50/125μm tight-buffered optical fibers enclosed by a protective sheath.

D. Listed type OFNP, OFNR, OFCR, and/or OFCP.

E. The cable will be capable of supporting applications using a bandwidth in excess of 1GHz over the 90 m (295ft) specified for horizontal cabling.

F. The optical fiber shall be multimode, graded-index with a nominal 50/125μm core/cladding diameter.

G. The mechanical and environmental specification for the optical fiber cable will be in accordance with ANSI/ICEA-S-83-596

H. Performance

<table>
<thead>
<tr>
<th>50/125 μm optical fiber</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength (nm)</td>
<td>Maximum Attenuation (db/km)</td>
</tr>
<tr>
<td>850</td>
<td>3.5</td>
</tr>
<tr>
<td>1300</td>
<td>1.5</td>
</tr>
</tbody>
</table>
I. Recommended number of fibers per cable: minimum 2 fibers, tight buffer style cable. Optional 4-6 fibers per horizontal tight buffer cable.

J. Approved Manufacturers: Corning, AFL, Commscope, Mohawk-CDT

PART 3 - EXECUTION

3.1 HORIZONTAL CABLING SYSTEM

3.1.1 Copper UTP

A. Install UTP cables using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.

B. All cable above the ceiling must be tied, independently and properly supported with hangers independent from the ceiling grid or other support systems. Contractor will provide all rings, supports, and raceways not provided on the documents for a proper cabling installation.

C. Special care will be taken to avoid damage to ceiling grid, ceiling tiles, or other installed work. Cable “draped” across ceiling tiles is unacceptable.

D. Plenum rated cable to be provided by contractor where required by code. Contractor should be familiar with NEC Article 300-22 and provide appropriate plenum rated cable.

E. Maximum cable length is 90 meters (295 ft.) Contractor will identify all cable runs exceeding 90 meters from proposed horizontal cross connect (HC) location and provide solution to meet the 90 meter requirement.

F. All wiring shall be protected from moving mechanical or physical contacts. All cabling shall be free from tension at both ends, as well as the length of each run.

G. Adhere to manufacturer’s published specifications for pulling tension, minimum bend radii, and sidewall pressure when installing cables.

1. Where manufacturer does not provide bending radii information, minimum-bending radius shall be 15 times cable diameter. Arrange and mount equipment and
materials in a manner acceptable to the engineer/designer and the Owner.

2. The maximum pull-force guideline for 4-pair horizontal balanced twisted-pair cables is 110N (25 lbf).

H. Horizontal cabling systems may not contain more than one consolidation point (CP) or one transition point (TP) in a horizontal cabling run. CP and TP connectors must meet the performance and reliability requirements specified in the ANSI/TIA/EIA-568-B standard.

I. Contractor to provide cable supports for all cable.

J. Exposed wiring will only be accepted in cases where other installation methods are not possible, e.g., a saw-toothed wooden ceiling or a tectum decked roof and are subject to the approval of the Owners Representative. Where aesthetics are a concern (i.e. visible to the occupants or public) and ceiling accessibility is not possible, surface mounted raceways may be considered for an installation. EMT may not be run exposed in any public space. A difficult installation will not be sufficient reason to avoid the requirement for non-exposed wiring. Exposed wiring will be acceptable in crawl spaces. Exception: adequately-supported and protected, exposed wiring may be used horizontally (not vertically) in exposed truss spaces in shop areas, shop corridors, mechanical rooms, and other specialty areas. Entry into the room must be sleeved and fire/smoke stopped. Vertical installations must be in a raceway.

K. Install exposed cables and raceways parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.

L. Separation from EMI Sources: Comply with BICSI TDM and ANSI/TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment. Comply with the following minimum separation distances from possible sources of EMI:

1. Separation between unshielded power lines or electrical equipment in proximity to open cables or cables in nonmetallic raceways is as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: 5 inches (127 mm).

   b. Electrical Equipment Rating between 2 and 5 kVA: 12
2. Separation between unshielded power lines or electrical equipment in proximity to cables in grounded metallic raceways is as follows:

a. Electrical Equipment Rating Less Than 2 kVA: 2-1/2 inches (64 mm).
b. Electrical Equipment Rating between 2 and 5 kVA: 6 inches (150 mm).
c. Electrical Equipment Rating More Than 5 kVA: 12 inches (300 mm).

3. Separation between power lines and electrical equipment located in grounded metallic conduits or enclosures in proximity to cables in grounded metallic raceways is as follows:

b. Electrical Equipment Rating between 2 and 5 kVA: 3 inches (76 mm).
c. Electrical Equipment Rating More Than 5 kVA: 6 inches (150 mm).

4. Electrical Motors and Transformers, 5 kVA or HP and Larger: 48 inches (1200 mm).

5. Fluorescent Fixtures: 5 inches (127 mm).

M. Comply with ANSI/TIA/EIA-569-A for maximum length of conduit and bends between pull points, and for pull-box sizing. Use manufactured conduit sweeps and long-radius ells whenever possible.

3.1.2 Fiber Optic

A. All cable above the ceiling must be tied, independently and properly supported with hangers independent from the ceiling grid or other support systems. Contractor will provide all rings, supports, and raceways not provided on the documents for a proper cabling installation.
B. Special care will be taken to avoid damage to ceiling grid, ceiling tiles, or other installed work. Cable “draped” across ceiling tiles is unacceptable.

C. Plenum rated cable to be provided by contractor where required by code. Contractor should be familiar with NEC Article 300-22 and provide appropriate plenum rated cable.

D. All wiring shall be protected from moving mechanical or physical contacts. All cabling shall be free from tension at both ends, as well as the length of each run.

E. The minimum bend radius of the fiber optic cable shall be 10 times the cable O.D. or as rated by the manufacturer, whichever is greater. Minimum bend radius shall be observed at all times.

F. Cable manufacturer’s recommendations shall be followed during the installation of the cable. Pull force shall be monitored and shall not exceed manufacturer’s ratings.

G. Cable endcaps shall be used at all times possible to prevent moisture from entering cable.

H. Following cable pull-in, the cable end to which the cable puller is fastened shall be removed and discarded. A minimum of three meters of cable shall be removed.

I. Cable pulling compounds shall be compatible with fiber optic cable in accordance with cable manufacturers recommendation.

J. A new cable tray shall be installed in each telecommunication room to train the cables over to the communication racks. End of trays shall be supported from the wall. Trays longer than 10’ shall also be supported at tray midspan from the deck above. The fiber optic cable shall be installed in the tray separate from the twisted pair cable to avoid having the twisted pair cable bear any weight on the fiber optic cable.

K. A 30’ service loop of cable shall be provided in the cable tray above each fiber optic cabinet.

L. The cable shall be properly secured at the fiber housing panel using manufacturers recommended means for attachment.

M. Arrangement of the components in the fiber rack and cabinets shall be approved by the Engineer/Designer.

N. Install one new connector housing panel in each communication room in the communication rack.
3.2 TESTING

A. Testing requirements shall conform to ANSI/TIA/EIA-568-B.1,
   ANSI/TIA/EIA-568-B.2 standard for balanced twisted-pair and
   ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.3, TIA/EIA TSB-140,
   ANSI/TIA/EIA-526-7, ANSI/TIA/EIA-526-14A for optical fiber cabling
   systems.

B. Test each pair and shield of each cable for open circuits, short circuits,
   grounds, crossed pairs, reversed pairs, split pairs, and improper
   terminations. Correct grounded and reversed pairs. Examine open and
   shorted pairs to determine if problem is caused by improper termination.
   If termination is proper, tag bad pairs at both ends and note on
   termination sheets.

1. Perform testing of copper cables with test instruments meeting or
   exceeding applicable requirements in ANSI/TIA/EIA-568-B.2.

2. Channel and permanent link tests for wire map, cable length,
   insertion loss, near-end crosstalk loss (NEXT), power sum near-
   end crosstalk loss (PSNEXT), equal-level far-end crosstalk loss
   (ELFEXT), power sum equal-level far-end crosstalk (PSELFEXT),
   return loss, propagation delay, and delay skew. Tests shall be
   performed with a tester that complies with performance
   requirements in ANSI/TIA/EIA-568-B.2, Level III. Include tests for
   longitudinal or transverse conversion loss.

3. In open office cabling, testing to a multi-user telecommunications
   outlet assembly (MUTOA) or a consolidation point (CP) should be
   subject to permanent link requirements. The permanent link
   including the CP should also be tested after installation of the
   open office cabling. Refer to ISO/IEC 11801 Ed.2:2002 provide
   CP link and permanent link pass/fail criteria.

4. If copper backbone cable contains more than one (1) percent bad
   pairs, remove and replace entire cable.

5. If copper cables contain more than the following quantity of bad
   pairs, or if outer sheath damage is cause of bad pairs, remove and
   replace the entire cable:

<table>
<thead>
<tr>
<th>CABLE SIZE</th>
<th>MAXIMUM BAD PAIRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100</td>
<td>1</td>
</tr>
<tr>
<td>101 to 300</td>
<td>1-3</td>
</tr>
</tbody>
</table>

HORIZONTAL CABLING
6. If horizontal cable contains bad conductors or shield, remove and replace cable.

C. Test end-to-end attenuation of optical cable with a stabilized light source and optical power meter utilizing procedures as stated in ANSI/TIA/EIA-526-14A: OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant. Measured results shall be plus/minus 1 dB of submitted loss budget calculations. Correct improper splices and replace damaged cables at no charge to the Owner.

1. Cables shall be tested at both 850 and 1300 nm to ensure predicted system performance.

2. The maximum allowable attenuation for a 50/125µm multimode link is 2.0 dB. This value is based on the loss of two mated connector pairs plus 90m (295 ft) of optical fiber cable. Attenuation need only be measured in one direction.

3. The maximum allowable attenuation for open office cabling, implemented with a consolidation point (CP) is 2.75 dB. For open office cabling implemented with a MUTOA, the maximum attenuation is 2.0 dB.

4. All system connectors, adapters, and jumpers must be properly cleaned before measurements are taken.

D. Perform optical time domain reflectometer (OTDR) inspection and traces per Tier 2 of TSB-140 on each fiber optic conductor when the end-to-end attenuation readings are high. Measured results shall be plus/minus 1 dB of submitted loss budget calculations.

1. Submit printout for each cable tested.

2. Submit compact discs (CD) with test results and program to view results.

E. Where any portion of system does not meet the specifications, correct deviation and repeat applicable testing at no additional cost to the Owner.

END OF SECTION 27150
SECTION 27160 – WORK AREA (CONNECTING CORDS AND DEVICES)

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. This Section specifies the work area components in a structured cabling system.
   2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

B. Related Sections:
   1. Division 1 – General Requirements
   2. Section 27000 – Communications General

1.2 SYSTEM DESCRIPTION

The work area shall consist of the connectivity equipment used to connect the horizontal cabling subsystem and the equipment in the work area. The total patch cord length at the work area is not to exceed 3 meters (10 ft.). Exception: When implementing open office distribution systems as specified under TIA/EIA TSB-75. i.e. Multi-User Telecommunications Outlet Assembly (MUTOA).

1.3 SUBMITTALS

A. Shop Drawings
   1. Modular Connectors
   2. Copper and/or Fiber patch cords.

1.4 QUALITY ASSURANCE

A. Refer to Section 27000 for quality assurance requirements.
PART 2 – PRODUCTS

2.1 MANUFACTURERS

Product selection subject to compliance with the Owners standard requirements, provide products by one of the manufacturers specified.

2.2 FABRICATION

Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.

2.3 SUITABILITY

Provide products that are suitable for intended use, including, but not limited to environmental, regulatory, and electrical.

2.4 WORK AREA

2.4.1 Modular Connectors and Patch Cords (Copper)

The network cabling system shall be comprised of modular connectors in support of high-speed networks and applications designed for implementation on copper cabling. All outlets shall utilize fully interchangeable and individual connector modules to facilitate quick and easy moves, adds, and changes.

A. Modular Connectors

Single-gang stainless steel faceplate, unless otherwise specified, with two (2) openings containing the following devices:

1. Voice Outlet – 8 position modular, Category 6, unkeyed, ivory, pinned to T568B standard.

2. Data Outlet – 8 position modular, Category 6, unkeyed, orange, pinned to T568B standard. The 8 position modules shall be used in all work areas and shall exceed the connector requirements of the ANSI/TIA/EIA Category 6 standard. Modules shall have UL approval and be universal in design, accepting 2,3, or 4 pair modular plugs without damage to the outer jack contacts. The modules shall be able to be re-terminated a minimum of 10 times.

Single-gang stainless steel faceplate with one (1) opening shall be used when providing voice or data only.

Single-gang stainless steel faceplate with four (4) openings shall be used when combining copper and optical fiber work area outlets.
Approved Manufacturers: Panduit, Siemon, Hubbell

B. Patch Cords

Category 6 patch cords shall be factory terminated with modular plugs featuring a one-piece, tangle-free latch design and strain-relief boots to support easy moves, adds, and changes. They shall be constructed with Category 6 24-AWG stranded UTP cable. Each cord shall be 100% performance tested at the factory in a channel test to the ANSI/TIA/EIA Category 6 standard. Required cable lengths and colors shall be approved by the Engineer/Designer prior to ordering.

Approved Manufacturers: Panduit, Siemon, Hubbell

2.4.2 Modular Connectors and Patch Cords (Fiber)

The network cabling system shall be comprised of Fiber Optic modular connectors in support of high-speed networks and applications designed for implementation on 50μm multimode glass fiber cabling. All outlets shall utilize interchangeable and individual connector modules to facilitate quick and easy moves, adds, and changes.

A. Modular Connectors

SC ceramic tipped fiber optic connectors shall be field terminable duplex fiber optic connectors for multimode glass fiber that fully complies with both the fiber optic connector performance requirements specified in ANSI/TIA/EIA-568-B.3. The multimode SC connector shall be compatible with 50/125μm, 3.0 mm jacketed or 900μm tight-buffered, multimode glass fiber. The connector shall have an insertion loss typically less than 0.3 dB per fiber. They shall be capable of field termination with commonly available tools. The cover and boots of the multimode SC connector shall be the industry standard electric ivory color signifying multimode fiber.

Approved Manufacturers: Panduit, Siemon, Hubbell

B. Patch Cords

SC optical fiber patch cords shall be constructed from high performance 50/125μm multimode cable and SC duplex connectors with ceramic ferrules. Integral boots shall be provided to provide strain relief and help maintain consistent polarity. Required cable lengths and colors shall be approved by the Engineer/Designer prior to ordering.

Approved Manufacturers: Panduit, Siemon, Hubbell

C. Optical Fiber Jumpers
Dual 50/125μm (and/or singlemode) optical fiber jumper cable, 1m long with 3.0 mm approved alternative duplex optical fiber connectors on each end.

D. Optical Fiber Pigtails

50/125μm (and/or singlemode) optical fiber pigtail 1 m long with 3.0 mm single 568 SC optical fiber connectors on one end.

PART 3 - EXECUTION

3.1 WORK AREAS

A. Install station cabling to the nearest telecommunications room (TR), unless otherwise noted.

B. All connections of twisted wiring shall be made in such a way as to minimize the extent in which each twisted pair is unraveled at the point of its physical termination. No more than 0.5 inches of exposed untwisted pairs shall be present at these locations. Cable bends shall be no less than eight times the cable diameter or 1.00”.

C. Provide additional cable slack at both ends to accommodate future cabling system changes. The recommended amount of slack is 3m (10 ft.) at the TR and 1.5m (5 ft.) hung in the ceiling for the telecommunication outlet. The minimum slack for termination of metallic cable is eight (8) inches. Include the slack in all length calculations to ensure that the horizontal cable does not exceed 90 m (295 ft).

D. Data Drops:

1. Classroom: One data outlet (and one power outlet) in the ceiling, plus at least two data outlets on each wall.

2. Office: at least two data outlets per occupant as designed.

3. Public Area: one data outlet (and power outlet) in the ceiling, located at all intersection points of a grid sectioned into 100 ft x 100 ft sections covering the public area. Drop layout must be approved by the Owners Representative in writing.

4. All other areas: Drop locations and quantities shall be provided by the Engineer/Designer and approved by the Owners Representative in writing.

END OF SECTION 27160
SECTION 27170 – TELECOMMUNICATIONS ADMINISTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. This Section specifies the administrative requirements and components in a structured cabling system.

B. Related Sections:

1. Division 1 – General Requirements
2. Section 27000 – Communications General

1.2 SYSTEM DESCRIPTION

A. An effective administration system is crucial to the efficient operation and maintenance of the telecommunications infrastructure and equipment in EMU’s campus environment.

1.3 SUBMITTALS

A. Cabling Administration Drawings: Show building floor plans with cable administration-point labeling. Identify labeling convention and show labels for telecommunications rooms, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas, and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA/EIA-606(A).

1.4 QUALITY ASSURANCE

A. Refer to Section 27000 for quality assurance requirements.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

Product selection subject to compliance with the Owners standard requirements, provide products by one of the manufacturers specified.

2.2 FABRICATION

Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.
2.3  **SUITABILITY**

Provide products that are suitable for intended use, including, but not limited to environmental, regulatory, and electrical.

2.4  **TELECOMMUNICATIONS ADMINISTRATION**

A. Comply with ANSI/TIA/EIA-606-A Class 4 and with applicable requirements in section 3.1 “Labeling”.

B. Labels can be adhesive, insert or other special purpose labels. Labels must meet legibility, defacement and adhesion requirements specified in UL969 (D16).

C. Computer based cable management system, with integrated database and graphic capabilities.

D. Document physical characteristics by recording the network, ANSI/TIA/EIA details, and connections between equipment and cable.

1. Information shall be presented in database view, schematic plans, or technical drawings.
   a. AutoCAD or Visio drawing software shall be used as drawing and schematic plans software.

2. System shall interface with the following testing and recording devices:
   a. Direct upload tests from circuit testing instrument into the PC.
   b. Direct download circuit labeling into labeling printer.

E. Approved Manufacturers: Brady, Panduit

**PART 3 - EXECUTION**

3.1  **LABELING**

Labeling shall conform to ANSI/TIA/EIA-606(A) Class 4 standards. Confirm with the Owners Representative prior to labeling for verification of labeling standards. In addition, provide the following:

A. Label each outlet with permanent self-adhesive label with minimum 3/16 inch high characters that provides the cross connect location, the rack field location and the position of the connection within the rack field. For example: 1-A-01 would refer to the other end of the termination being Main Cross-Connect (MC) 1, Patch Panel A, Position 01.
B. Label each cable with permanent self-adhesive label with minimum 1/8 inch high characters, in the following locations:

1. Inside receptacle box at the work area within 1” of termination.

2. Behind the communication closet patch panel or punch block within 1” of termination.

3. Exposed cables and cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5m).

C. Use labels on face and rear of data patch panels. All panels are to be labeled in a sequential, logical order (For example: A, D, C, B will be retagged and reterminated to A, B, C, D).

D. Provide facility assignment records in a protective cover at each telecommunications room location that is specific to the facilities terminated therein.

E. Use color-coded labels for each termination field that conforms to ANSI/TIA/EIA-606(A) standard color codes for termination blocks.

F. Color-code cross connect fields. Apply colors to voice and data service backboards, connections, and covers.

G. Labels shall be machine-printed using cable and asset management software specified in Part 2, Telecommunications Administration. Hand-lettered labels are not acceptable. Use unique, alphanumeric designation for each cable, and label cable, jacks, connectors, and terminals to which it connects with same designation.

H. Use logical and systematic designations for facility’s architectural arrangement and nomenclature, and a consistent color-coded identification of individual connectors.

I. Three (3) sets of as-built drawings shall be delivered to the Owners Representative within four (4) weeks of acceptance of project completion. A set of electronic as-built drawings shall also be provided on three (3) compact discs (CD) utilizing AutoCAD or Visio. The media shall be delivered to the Owners Representative within six (6) weeks of acceptance of project completion.

END OF SECTION 27170
SECTION 27190 – ADDITIONAL INFORMATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. This section specifies additional telecommunication requirements in a structured cabling system.

B. Related Sections:

1. Division 1 – General Requirements
2. Section 27000 – Communications General

1.2 SUBMITTALS

A. Shop Drawings

1. Equipment as noted in product section below.

1.3 QUALITY ASSURANCE

A. Refer to Section 27000 for quality assurance requirements.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

Product selection subject to compliance with the Owners standard requirements, provide products by one of the manufacturers specified.

2.2 FABRICATION

Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.

2.3 SUITABILITY

Provide products that are suitable for intended use, including, but not limited to environmental, regulatory, and electrical.

2.4 LISTED BUILDING ENTRANCE PROTECTORS

Building entrance terminal utilizing a two (2) foot fuse link between the outside cable plant splice and the protector module with IDC type input and output terminals. 100-pair capacity and female mounting base, equipped with 230 volt
solid state protector modules. Provide sufficient protector modules to completely populate all building entrance terminals.

2.5 GROUNDING AND BONDING

Materials: Comply with NFPA 70, ANSI/TIA/EIA-607, and UL 467.

PART 3 - EXECUTION

3.1 SURGE SUPPRESSION DEVICES

A. All surge suppression devices shall warranty protection of all downstream equipment.

3.2 GROUNDING AND BONDING

A. Grounding shall conform to ANSI/TIA/EIA-607(A) – Commercial Building Grounding and Bonding Requirements for Telecommunications, National Electrical Code, ANSI/NECA/BICSI-568 and manufacturer’s grounding requirements as a minimum.

B. Grounding Points:

1. Located grounding terminals in each equipment room, wiring closet, rack and cabinet.

2. Telecommunications Grounding Busbars (TGB): Mount on wall of telecommunications entrance facility, equipment room, and telecommunications room, with standoff insulators.

C. Grounding Conductors:

1. Extend from telecommunications entrance facility to electrical entrance facility and connect to grounding electrode.

2. Where a panelboard for telecommunications is located in the same room or space as a grounding busbar, bond to equipment ground bus of electrical panelboard.

3. Extend from telecommunications entrance facility to grounding busbars.

4. Extend from grounding busbars to ground terminals in equipment racks, frames and cabinets.
5. Extend from grounding busbars to building metal frame within room, or to metal frame external to room but readily accessible.

D. Special Requirements:

1. Bonding conductors shall be insulated, No. 6 AWG minimum.

2. Install only in nonmetallic conduit, unless specifically required for protection of conductor. Metallic conduit, if used, shall be RMC. For RMC that exceeds 36 inches (915mm) in length, conductors shall be bonded at each end of conduit.

3. Bonding conductors shall be installed without splices unless approved by Designer/Engineer because of special circumstances. Where splices are necessary, they shall be accessible and shall be located in telecommunications spaces. Splices shall be by irreversible compression connectors or by exothermic welding.

END OF SECTION 27190
**TYPICAL 10’x15’ EQUIPMENT ROOM**

**SCALE:** 1/4" = 1’-0"

**NOTES:**

1. CONVENIENCE RECEPTACLE IS SHOWN FOR ILLUSTRATION ONLY. PLACE OUTLETS AT 6 FT. INTERVALS AROUND PERIMETER WALLS.

2. LIGHT FIXTURES SHOWN FOR ILLUSTRATION ONLY. PROVIDE A MINIMUM EQUIVALENT OF 50 FOOTCANDLES WHEN MEASURED 3 FT. ABOVE FINISHED FLOOR (AFF).
EMU HIERARCHICAL STAR TOPOLOGY

NOT TO SCALE
TYPICAL TELECOMMUNICATION ROOM

SCALE: 1/4" = 1'-0"

NOTES:

1. THIS TELECOMMUNICATION ROOM SIZE WILL ACCOMODATE A SERVING AREA OF 5000 SQ. FT. OR LESS. CONSULT WITH ENGINEER/DESIGNER FOR ROOM SIZE REQUIREMENT, LAYOUT AND FINAL APPROVAL.

2. CONVENIENCE RECEPTACLE IS SHOWN FOR ILLUSTRATION ONLY. PLACE OUTLETS AT 6 FT. INTERVALS AROUND PERIMETER WALLS.
HORIZONTAL LINK IDENTIFIER HAVING FORMAT FS--A--N, WHERE
F=NUMERIC CHARACTER(S) IDENTIFYING THE FLOOR OF THE
BUILDING OCCUPIED BY THE TELECOMMUNICATION ROOM (TR).
S=ALPHA CHARACTER(S) UNIQUELY IDENTIFYING THE TR ON
FLOOR F, A=ONE OR TWO ALPHA CHARACTERS UNIQUELY
IDENTIFYING A SINGLE PATCH PANEL OR A GROUP OF PATCH
PANELS WITH SEQUENTIALLY NUMBERED PORTS AND N=ONE TO
FOUR NUMERIC CHARACTERS DESIGNATING THE PORT ON A
PATCH PANEL IN THE TR.

OUTLET COLOR AS SPECIFIED

STAINLESS STEEL FACEPLATE
-- SIZE PER OUTLET BOX
(SINGLE GANG, DOUBLE GANG,
ETC.)

WORK AREA (WA)
WALLPLATE
(FLOORBOX SIMILAR)

SUPPORT CABLES EVERY 5' OR LESS

LABEL EACH RACK PATCH PANEL
ON LEFT AND RIGHT SIDE.

HORIZONTAL CROSS-CONNECT
(HC) PATCH PANELS

NOT TO SCALE
TYPICAL 9'x10' TELECOMMUNICATION ROOM

SCALE: 1/4" = 1'-0"

NOTES:

1. THIS TELECOMMUNICATION ROOM SIZE WILL ACCOMODATE A SERVING AREA OF >5000 SQ. FT. TO 8000 SQ. FT.

2. CONVENIENCE RECEPTACLE IS SHOWN FOR ILLUSTRATION ONLY. PLACE OUTLETS AT 6 FT. INTERVALS AROUND PERIMETER WALLS.
TYPICAL 10’x11’ TELECOMMUNICATION ROOM

SCALE: 1/4" = 1’-0”

NOTES:

1. THIS TELECOMMUNICATION ROOM SIZE WILL ACCOMODATE A SERVING AREA OF >8000 SQ. FT. TO 10000 SQ. FT.

2. CONVENIENCE RECEPTACLE IS SHOWN FOR ILLUSTRATION ONLY. PLACE OUTLETS AT 6 FT. INTERVALS AROUND PERIMETER WALLS.
TYPICAL SMALL TELECOMMUNICATION ROOM

SCALE: 1/4" = 1'-0"

NOTES:

1. THIS TELECOMMUNICATION ROOM SIZE IS SUITABLE FOR A MAXIMUM OF 240 TERMINATIONS.

2. CONVENIENCE RECEPTACLE IS SHOWN FOR ILLUSTRATION ONLY. PLACE OUTLETS AT 6 FT. INTERVALS AROUND PERIMETER WALLS.
TYPICAL SHALLOW TELECOMMUNICATION ROOM

SCALE: 1/4" = 1'-0"

NOTES:

1. A SHALLOW ROOM IS DEFINED AS AN ENCLOSED SPACE FOR HOUSING CABLE TERMINATIONS, CROSS-CONNECT CABLE, AND TELECOMMUNICATIONS EQUIPMENT.

2. SLEEVE PLACEMENT MUST BE CONSIDERED WHEN USING A SHALLOW ROOM SO THAT THERE IS VERTICAL ALIGNMENT WITH TRs ABOVE AND BELOW.